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NOTES AND COMMENTS

Tate & Lyle Ltd. 1957 Results.

In common with many other industries, Tate & Lyle Ltd. have played their part, at the special request of the government, in absorbing increasing costs. They were able to keep the margin between the price of raw sugar and the selling price of refined sugar unchanged until the middle of the summer. But during the 18 months that the margin remained unaltered, wages, fuel and other costs had been mounting. It was possible to wait no longer for the brake on inflation that they had been led to expect would result from government action. When, therefore, the retail price was helped not only by a fall in raw sugar prices, but by the Sugar Board's distribution payment, the refining margin was adjusted. However, it is still well below the maximum figure guaranteed to the Chancellor of the Exchequer.

The Company has had a good year for exports, both in volume and margins, 13,500 tons leaving London or Liverpool for export each week. There has been some shift in the markets supplied. For instance, the Far East and the Middle East were down by some 40%, but total exports were up by 25% due to increased business to European countries and to Russia. Tate & Lyle believe that their quality and service is the best in the world, and if they can maintain their superiority in these fields they will keep their trade, and indeed increase it, in spite of threats from countries such as India to wrest some of the Company's business from them, even if she has to sell at a loss. And also in spite of handicaps such as the inflated price of hessian bags due to the subsidy paid to the Dundee jute industry of about 1s 0d a bag.

This year, in spite of political disturbances, Cuba could harvest 6¼ million tons of sugar (an increase of three-quarters of a million over last year). Thus 1958 is likely to see a progressive growth in raw sugar stocks which should be reflected in prices, particularly because most sugar-producing countries can sell surplus output profitably at prices well below that ruling at present. With falling prices there will be a lessening of the burden of financing stocks of raw sugar, the value of which has increased sharply in 1957 compared with 1956.

During the year the Rhodesia Sugar Refinery Co. increased its Ordinary capital by 750,000 Ordinary shares of 5s 0d each, all of which were issued to Tate & Lyle at a price of 8s 0d per share. As a result, Tate & Lyle and Tate & Lyle Investments together now hold 45% of the issued capital of the R.S.R. Co. The Company has refineries in Salisbury and Bulawayo. A third refinery is being built at Ndola in Northern Rhodesia at an estimated cost of £1,000,000. This sum is being financed initially by overdraft from Barclays Bank (D.C. & O.) under the guarantee of Tate & Lyle and Tate & Lyle Investments.

All the difficulties at Chirundu, the other Tate & Lyle Rhodesian venture engaged in raw sugar production, have not yet been finally overcome, but the steps that have been taken show great promise and the project should start to make profits in 1959.

In Canada, the erection of the new refinery at Toronto by the Canada & Dominion Sugar Co. is going according to plan. The refinery will be in operation in 1959, by which time the St. Lawrence seaway will be open. Sugar Line Ltd. are carrying six cargoes to Canada this year, an increase of three over last year.

All the Company's ships have had a good year, although falling freight rates have seriously affected the trading in recent months. Sugar Line and Silvertown Services vessels carried nearly half a million tons of bulk raw sugar. The Sugar Line fleet is to be increased by one vessel of 11,000 tons which will be constructed to discharge at a new jetty being designed for Thames Refinery. Silvertown Services are also adding a vessel to their fleet. This will be 8000 tons and will be constructed to discharge at the existing jetty at Plaistow Refinery.

By modern standards, Tate & Lyle are not large employers. In offices and refineries there are rather fewer than 10,000 people, of whom nearly a third are women. Their output, however, is very large. Over four tons of refined sugar per week is produced for each person employed. There is about £2,000 worth of equipment for every person who is working.

A final Ordinary dividend of 12%, making 16½%, less income tax, for the year, was approved.

A feature of the Accounts is the very attractive series of colour photographs portraying a West African market scene, and the cube sugar process starting with a vacuum pan and showing moulding and press cube equipment together with a fully automatic plant used to produce a new product, Crystal Cube sugar, which combines the best features of moulded and pressed cubes. A drawing depicts the interior of HENRY TATE'S grocery shop in about 1860, a feature being the sugar loaves and the loaf-breaking machines.

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Ten Dynamic Years.

This is the title of a booklet issued by the Hawaiian Sugar Producers' Association and refers to the period 1947 to 1957. It is prefaced by a section "An Industry at War" which describes defence preparations as they existed prior to the Japanese attack on Pearl Harbour and the contributions by the Hawaiian industry to the war effort. After 1945, men were recruited from the Philippines to fill the labour shortage, and an account is given of the crisis which led to a severe strike from 1st September to 19th November 1946. This troubled situation was the background from which has developed the improved relations of the industry which have provided new security for labour and management such that grievance procedures, seniority provisions, rate protection, etc., were specified, while mechanization was extended so that the employee population was reduced from 27,000 in 1947 to 17,000 in 1956. Approximately 24% of employees owned their own homes in 1957 compared with almost none in 1947; the proportion of non-citizens dropped by 20%; and the number of employees in the lower labour grades dropped from 46% to only 19%. Pension arrangements have been introduced and training for higher skills instituted.

A chapter "New Tools for Better Jobs" describes the great changes which have taken place, including replacement of locomotives and cane cars with giant road hauling equipment; the introduction of the Storey and Towner disc ploughs and the Howard rotary hoe; the use of chemical herbicides, distributed from tractor-mounted spray booms or from aircraft; new cane cutters, windrowers and infield transport; the transition from bagged to bulk sugar; use of higher pressure steam boilers, steam turbines for mill drive, and fully automatic centrifugals.

"Science in the Field" describes the achievements of the H.S.P.A. Experiment Station which have contributed to the achievement in 1956 of an average of 10·28 tons of sugar per acre. Those mentioned include the chemical control of tasselling; fertilizer programme planning; the introduction of aqueous ammonia; weed control with chemicals; irrigation research; the use of radio-isotopes; and by-products utilization.

Three chapters describe the marketing of Hawaiian sugar; the capital investment programmes (totalling $114,000,000 since 1946); and the Federal and International acts and agreements governing the industry.

A final chapter "The Sum and Substance" reviews past accomplishments and discusses future requirements for a successful and healthy Hawaiian industry.

The Annual Report of the President of the H.S.P.A. for 1957 also briefly describes the achievements of the past ten years and the changed conditions in marketing and packaging which have occurred. While the price of sugar has remained relatively constant, basic wage rates have risen 59%, transportation cost 68%, and wholesale commodity index, reflecting purchases, have risen 22%. Increased yields and mechanization are the factors which have enabled the industry to remain marginally profitable.

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World Raw Sugar Prices.

After a period of fluctuation, the raw sugar market has been fairly steady up to the time of writing (17th January), in spite of reports of firing of cane fields by the rebels in Cuba. The cane supply in Cuba is very much more than is required for the decreed output, so that more concern would be shown if the factories were damaged. Chinese purchases have removed some Brazilian supplies which might have depressed the market, and other influences have been the rumour of further Chinese requirements and enquiries from the U.S.S.R.[1]

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U.S. 1958 Sugar Quotas.[2]

The U.S. Department of Agriculture announced on 20th December the sugar quotas set for 1958. These totalled 8,800,000 short tons, raw value, the same as the initial quotas set for 1957, the final figure for which was 8,975,000 tons. Consumption for 1958 is estimated at 8,900,000 tons, although actual distribution might be reduced by about 150,000 tons of constructive deliveries or deliveries in transit resulting from anticipated large deliveries of 1957 year-end beet sugar.

C. Czarnikow Ltd.[3] point out that under the terms of the U.S. Sugar Act the quotas of Peru and Costa Rica amount to 69,547 and 3264 tons, respectively, but, because of the limitations imposed by the International Sugar Agreement on imports from non-signatory countries, these have been reduced to 55,588 tons and 1123 tons. The full quotas would, of course, become available to these two countries if they were to sign the Agreement during the year or if, for any reason, the Agreement quotas become inoperative. Otherwise the portions which may not be entered will probably eventually be re-allotted to other full-duty countries.

[1] C. Czarnikow Ltd., *Sugar Review*, 1958, (337), 15.
[2] *Lamborn*, 1957, **35**, 270.
[3] *Sugar Review*, 1958, (335), 8.

FUNGI HELP TO RID THE SOIL OF EELWORM

By C. L. DUDDINGTON.

THE rise of the eelworm as a world-wide pest is one of the greatest agricultural problems of the present century. Crops as far apart as potatoes, tea, tobacco and pineapples are ravaged and, so far, control measures have had very little success. The 15th Annual Report of the Hawaiian Sugar Technologists now underlines the importance of eelworms to the sugar planter.

At least six different species of eelworm damage sugar cane, and among these the root-knot eelworms (species of *Meloidogyne*), together with species of *Pratylenchus* and *Trichodorus*, are the most harmful. For some years the "running-out" of sugar cane, necessitating the continual planting of new varieties, has been a serious trouble. Part of this appears to be due to ratoon stunting disease caused by a virus; but it now seems possible that eelworms are also implicated.

An eelworm is a minute creature, all but invisible to the naked eye. It is well described by its name; under the microscope it moves with vigorous threshing movements, very much like an eel. Eelworms are found almost everywhere, especially in rotting organic matter and in the soil. Many of them are entirely harmless, living on the fluid products of decomposition or on bacteria; those that attack crops do so by puncturing the tissues of the plant and sucking its juices. Not only does this harm the plant directly, but the damage caused may "let in" parasitic fungi, thus producing a secondary infection that may be as harmful as the eelworm.

Like most parasites that live in the soil, eelworms are very difficult to control. They occur in enormous numbers, their powers of reproduction are very great, and as they may be distributed throughout the top nine inches or so of soil the problem of getting at them with any chemical killing agent is a nightmare for the agricultural engineer. Soil fumigation, the only chemical control at present available, involves the introduction of a volatile liquid deep enough in the soil for its vapour to reach all the eelworms that are present. Special injecting gear is needed; this makes the work expensive, apart from the high cost of the chemicals. Moreover, soil fumigation is not satisfactory on a large scale.

Conventional methods having proved inadequate, scientists are now turning their attention to biological control. All organisms in Nature have other organisms preying on them. The object of biological control is to use these natural enemies of a pest to destroy it. This has been done with success in various parts of the world; for instance, the scale insect, which at one time threatened to wipe out citrus cultivation in California, has been checkmated by introducing the ladybird beetle from Australia.

What are the chances of using this method against the eelworm? On the face of it they seem reasonably good. Eelworms have many natural enemies, and of these the most promising are the curious microscopic fungi, known as predacious fungi, that bear traps in which eelworms are captured alive for food.

Predacious fungi are very common in organic matter and soil—anywhere, in fact, where eelworms are numerous. They live mainly on the non-parasitic free-living eelworms that are so common almost everywhere, but they are able and willing to tackle the eelworms that parasitize crops. Experiments carried out in France during the early 1940's showed that predacious fungi could capture and kill many of the eelworms that attack crops and domestic animals. As agents for the biological control of eelworms these fungi appear to have all the attributes needed—including the important one that they can be grown in the laboratory for distribution where they are needed.

Under the microscope the predacious fungi are seen to be made up of very fine threads, called *hyphae*, and it is to these that the eelworm traps are attached. There are various kinds of trap. *Arthrobotrys oligospora*, a common species, has curling side-branches from its hyphae which bend round and join up with other branches, forming tangles of networks. These work like fly-papers. The loops are sticky, and if an eelworm touches them it is held fast however hard it struggles. Within an hour or so it is dead, and branches from the network grow into its body and consume its contents. A single network can capture eelworms by the dozen, and, as the networks are distributed at frequent intervals along the hyphae of the fungus, the slaughter can be diabolical.

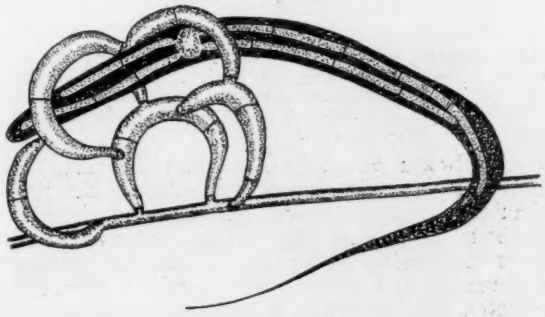

Fig. 1.

An eelworm captured by a fungus with sticky networks. The eelworm has thrust its head into the network, and is held like a fly on a fly-paper. Filaments of the fungus have grown into the body of the eelworm and are absorbing its contents. Very much magnified.

Other kinds of sticky trap are known. In some species of *Dactylella* the hyphae have side-branches that remain short and do not join up to form networks. These branches are sticky and catch eelworms as the networks do. In *Dactylella ellipsospora* and some other species the hyphae have tiny sticky knobs attached to them by short stalks. All these sticky traps are highly efficient, especially the networks.

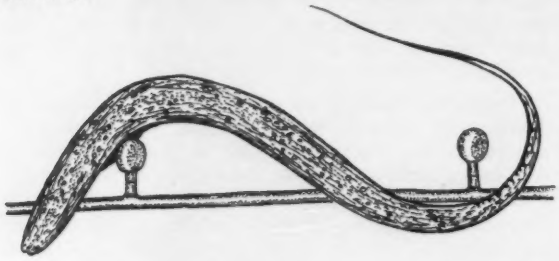

Fig. 2.

An eelworm captured by an adhesive knob. Two knobs are shown, attached to a fungal filament; that on the left has captured an eelworm by means of a sticky fluid (shaded black). Very much magnified.

The predacious fungi do not stop at producing natural fly-papers, for some of them "lasso" their prey like cowboys. These are the constricting ring bearers. Attached to their hyphae by short stalks are little rings, each of about the same diameter as an eelworm. The ring is made up of three cells, placed end to end and joining up to form the ring.

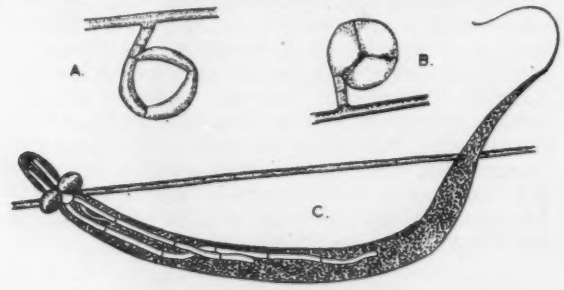

Fig. 3.

The constricting ring or "lasso" mechanism for catching eelworms. *A*—a ring before constriction. *B*—a ring after stimulation. *C*—a captured eelworm; the swollen ring cells are here seen in side view. *A* and *B* drawn to a larger scale than *C*. All very magnified.

If an eelworm passes its head into the ring, the friction of its body against the inside of the ring stimulates the cells to swell suddenly and violently to about three times their original volume. This closes the opening in the ring, so that the eelworm is caught as in a noose. For a while it struggles violently, but inevitably it must succumb to the fungus which, as before, sends branches into the victim's body and consumes its contents.

The efficiency of these ring snares is increased by the fact that they are held vertically on their stalks, making it easy for an eelworm to pass its head into the noose. The rings are very numerous and placed so close together that an eelworm caught by the head will often flick its tail into another ring during its struggles and so be doubly held.

The first attempts to use predacious fungi against eelworms attacking crops were made in Hawaii, shortly before the last war, by LINFORD and his colleagues. The pineapple root-knot eelworm was the subject of the experiments. Six different isolates of predacious fungi were used in the first trials, in which soil was inoculated with cultures of the fungi. These initial experiments were unsuccessful. LINFORD then turned his attention to the predacious fungi that were naturally present in the soil of the Hawaiian pineapple fields, with a view to stimulating them into increased activity so that they would do the work of eelworm destruction without the soil having to be specially inoculated. He considered that, since free-living eelworms were the natural prey of the fungi, an increase in the soil population of these harmless eelworms might so arouse the predacious activity of the fungi that they would start a general massacre in which the root-knot eelworms would suffer along with their harmless cousins.

To induce this stimulation LINFORD tried green manuring the soil with chopped pineapple plant tops. He was completely successful. The treatment was followed by a dramatic increase in the population of free-living eelworms in the soil of his experimental pots, which was followed by a great increase in the activity of predacious fungi. A little later it was found that there was a startling reduction in the numbers of free-living eelworms *and also of the infective larvae of the root-knot eelworm.* More than that, pineapples grown in treated soil showed far less eelworm damage than untreated "control" plants. It seemed as if LINFORD were on the right track.

It is unfortunate that, after this initial success, we have heard no more from Hawaii. LINFORD'S work has, however, received confirmation from recent work in England, where similar results have been obtained against cereal root eelworm attacking oats. Further experiments in England on cereal root eelworm, potato root eelworm and pea root eelworm have indicated strongly that best results are to be expected when inoculation of the soil with cultures of predacious fungi grown in the laboratory is accompanied by application of organic matter of some kind, especially green plant material.

As a means of protecting sugar cane from eelworm, biological control should be a promising line of inquiry. LINFORD'S work is particularly encouraging since it was carried out under tropical conditions and since the root-knot eelworm is known to be a pest of sugar cane. Predacious fungi are easy to grow in bulk and easy to apply to the soil; and no costly and troublesome process of soil injection is needed. There is still much to be done before their general use can be looked for, but given the manpower and facilities for research there is no reason why they should not make a valuable contribution to sugar-growing in the not too far distant future.

Herbicide Trials in Sugar Cane. *Kenya Dept. Agric. Ann Rpt.*, 1955.—Promising earlier trials with pre-emergent MCPA for control of dicotyledonous weeds (or non-grass weeds) and TCA for grass weeds are referred to. The results of further trials with these herbicides, with PCP, and with various combinations of these preparations, are given. The combination (TCA plus MCPA) was the most successful treatment and results in the highest yield of cane. The level of yield was low, however, as no treatment was able to keep the cane free of weeds for long enough between planting and canopy formation.

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Variety Trials in Kenya. *Kenya Dept. Agric. Ann. Rpt.*, 1955.—Details are given of cane variety trials at three different centres. At Kala Singh's farm in the Kibos area yields from sixteen varieties and constituting one plant crop and two ratoon crops varied from 52 to 143 tons per acre, the leading varieties being Co 331, Co 213, Co 434 and B 3337. At Miwani the leading varieties were Co 411, N:Co 291, Co 453 and B 37193, and at Kakamega B 3337, Co 421 and Co 417. It is interesting to observe that although ratoon stunting disease was confirmed in some of the varieties in the Kibos area in 1954 this disease "appears to have had little effect upon the second ratoon crop under adequate rainfall".

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Fertilizer Test Results, 1956. M. HALMA. *Maandber. Proefsta. Java-Suikerind.*, 1957, (8), 207–239.—This mimeographed report contains a detailed account of fertilizer or manurial trials carried out to ascertain the optimum fertilizer requirements of different varieties of sugar cane under different environmental conditions. The results are given mainly in tabular form and their significance discussed. In these trials the variety POJ 3067 proved rather more sensitive to under-nourishment than did POJ 3016. Sixteen other POJ varieties were used in the trials.

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Chemical Weedkillers in Java. J. J. DUYVERMAN. *Mededel. Java-Suikerind.*, 1957, (4), 26 pp.—A detailed account is given of experimental work on chemical weed control on a sugar estate in Java (Sumberhardjo, Pemalang). The work was concerned with both the cane fields and the railway tracks. Control on the railway tracks (32 miles in all) proved very successful. Six treatments per annum, each requiring two days, proved sufficient, spraying being done from a special tank locomotive. The spray consisted of a mixture of TCA (sodium trichloracetate) and Shell Weed-killer D in water. Reduction in cost compared with normal weed control was estimated to be 50–60%, Where lalang grass (*Imperata cylindrica*) was present in quantity a modified treatment was necessary. On the cane fields results were not so successful and it was not possible to find a sufficiently selective herbicide or combination of herbicides for use with young sugar cane. A certain amount of crop injury took place with all the herbicides tried, which was unexplainable considering the results reported from other countries.

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Characteristics of Varieties POJ 3137—POJ 3142. L. A. BIAUW. *Maandber. Proefsta. Java-Suikerind.*, 1957, (9), 284–289.—The agricultural characteristics of six of the newer varieties of sugar cane that have been raised in Java, viz. POJ 3137—POJ 3142, are described in some detail. The parentage and origin of each variety is indicated. There is also information on rate of growth, habit or growth form, tillering, flowering, disease and pest resistance.

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Cane Research in Java. ANON. *Maandber. Proefsta. Java-Suikerind.*, 1957, (10), 314–348.—Impressions of a visitor to Hawaii on sugar cane cultivation in that country are recorded, and informative articles on pollination out-stations in Java and the flowering of sugar cane and on variety trials are included. With the reorganization of the Pasuruan research station in 1952, after complete disruption caused by the war, steps were taken to establish an out-station for pollination and breeding work on the Malang plateau where the higher altitude induces flowering with many varieties that do not flower or flower freely at Pasuruan, such as the valuable commercial variety POJ 3016. Furthermore, a much higher percentage of fertile seed is obtained per flowering head at the higher altitudes. The station at Blimbing was available for the 1955, 1956 and 1957 seasons and another is expected to be available for the 1958 season. Reference is made to the building up of stocks of the well-known Indian (Coimbatore) cane Co 419 for distribution to growers for trial or comparison with established POJ varieties. Damage caused to cane crops in some areas by wild pigs, rats and monkeys is referred to.

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The Use of Cane Trash. ROBERTO FERNANDEZ DE ULLIVARRI. *Esta. Exp. Agric. Tucuman Circular*, 1957, (154), 9 pp.—The arguments for the incorporation of trash in the soil as against burning it are set forth.

Seven Years' (1950–1956) Investigation of Liquid Ammonia Fertilizers' Direct Application to the Soil. K. Y. LI. *Taiwan Sugar*, 1957, **4**, (2), 13–21.—The production of synthetic ammonia in Taiwan in 1949 has placed at the disposal of the sugar industry of that island a supply of both anhydrous and dissolved ammonia. Here the experiments subsequently conducted with ammonia, both in the anhydrous form and dissolved either in water or in wash concentrate, are summarized. On the basis of equivalent nitrogen, yields are approximately the same as those obtained with sulphate of ammonia if adequate care is taken to prevent loss by evaporation. Generally, placement at a depth of 20 inches is recommended. Actual cost of a unit N as aqueous ammonia (24·7% N) is 33% less than that of the same unit as sulphate of ammonia, but additional charges for storage, transport and application reduce this figure to 27%.

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Cane Growing Practices in Hawaii and West Indies. E. STEWARD. *S. African Sugar J.*, 1957, **41**, 555–561. This first of two extracts from the report of the field manager of Sir J. L. Hulett & Sons Ltd. gives the impressions gained in the fields during a visit to the two areas of land preparation and cultural operations in general.

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Agricultural Practices in the South African Sugar Belt, No. 2. ANON. *S. African Sugar J.*, 1957, **41**, 563–567.—The article describes the varietal position and cultural practices with, in particular, fertilizer policy on the estates of Sir J. L. Hulett & Sons Ltd.

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Trial of a New Cultural Method in Martinique. H. HAYOT. *Rev. Agric. Sucr. Rhum. Antilles Franç.*, 1957, **2**, 19–23.—The new method referred to is one drawn up by M. VAN DILLEWIJN during his brief tenure of Adviser. It is, broadly, a system of contour cultivation involving on occasion "false furrows". The advantages and disadvantages as indicated by a preliminary trial are briefly indicated.

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Termites and their Destruction. S. GROEVIUS. *Rev. Agric. Sucr. Rhum. Antilles Franç.*, 1957, **2**, 25–28.—From a trial with a number of insecticides, it would appear that "Heptax" in a concentration of 1–2% is most effective and that application is best made to the nests after harvesting.

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1956 Studies of Stunting Disease in Louisiana. C. A. SCHEXNAYDER and E. V. ABBOTT. *Sugar Bull.*, 1957, **35**, 334–339.—Comparisons are given of the differential yields of both cane and sugar for the plant and first stubble of a number of varieties as the result of hot air treatment. Among those studied are some of the old, but discarded, commercial varieties, the objective being to determine whether stunting disease played an unsuspected rôle in the degeneration of these. The results strongly suggest that it did. Included in the varieties are a number as yet unreleased.

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Results of Sugar Cane Variety Tests in Louisiana during 1956. R. J. MATHERNE and L. P. HEBERT. *Sugar Bull.*, 1957, **35**, 309–322. **Outfield Sugar Cane Variety Trials, 1956.** T. J. STAFFORD. *Sugar Bull.*, 1957, **35**, 340–357.—These two papers form a massive exposition of a large number of varietal tests, both plant and first stubble. Certain of the trials were conducted with heat-treated cane, and it would seem that such treatment leads to higher cane yields with poorer juice.

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Sugar Cane Fertilization. D. S. BYRNSIDE, Jr., and M. B. STURGIS. *Sugar Bull.*, 1957, **35**, 323–333.—The results of a number of fertilizer experiments under varying conditions in Louisiana are given in considerable detail, and the results of these and previous experiments are summarized in the form of recommendations.

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Effects of certain Defoliants and Growth Regulators upon Sugar Cane. R. E. COLEMAN and L. P. HEBERT. *Sugar Bull.*, 1957, **35**, 389–391.—Claims have from time to time been made that certain substances falling under the above heading increase the sugar content of the crop sprayed[1]. Trials of a number of such substances are recorded, all giving negative results as regards increased sugar. Certain of them acted as defoliants, but the cane leaf has no abcission layer as has cotton, and the shrivelled leaf must subsequently be burned.

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The Influence of Phosphate and Nitrate Fertilizers on the Composition of Foliage and Beets. G. ELMERS. *Socker Handl.* II, 1956, **12**, 197–203.

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Molasses and Filter-Press Mud as Fertilizer. *Kenya Dept. Agric. Ann. Rpt.*, 1955.—Trials were carried out, at Miwani, on the effects of molasses and filter-press mud, in combination with ammonium sulphate, on the growth or yields of cane. Results suggested a possible small response to filter-press mud but no apparent response to molasses.

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Recommendations for Harvesting Cane. ROBERTO FERNANDEZ DE ULLIVARRI. *Esta. Exp. Agric. Tucuman Circular*, 1957, (152), 3pp.—The necessity of ensuring delivery of clean cane, of harvesting at optimum maturity and of avoiding delays between cutting and grinding are emphasized.

[1] *I.S.J.*, 1953, **55**, 171.

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AN INSTRUMENT FOR CONCENTRATION OR SUPERSATURATION RECORDING

Of Boiling Sugar Solutions

By G. V. GENIE, Dr.Sc. (Raffinerie Tirlemontoise S.A., Tirlemont, Belgium)

PART III

Description of Instruments

Three types of supersaturation measuring instruments have been developed.

The first—type A—described in a previous paper[1] is now obsolete.

The second—type B—is built around a high-resistance bridge powered by a stabilized DC voltage source. The difference of potential ΔE is measured by means of a symmetric cathode-follower stage using two high-μ industrial pentodes. This circuit gives sufficient power to operate an inexpensive galvanometric recorder without built-in amplifier.

The third—type C—is a purely electrical circuit composed of a low-resistance bridge powered by a low-voltage DC source and a measuring instrument with crossed coils, the measuring coil being connected across the bridge and the directing coil on a derivation of the DC feed. The reading of the instrument is thus the ratio $\Delta E/E$ which is unaffected by the variations of the power line. This type of instrument is useful in locations where specialized manpower for electronic maintenance is not available.

(A) *Supersaturation-recorder type B.*

Twenty-five thermistors type B 1 megohm/25°C were purchased from the Compagnie Industrielle des Céramiques Electroniques, of Montreuil-sous-bois, France. They were aged for three months in a drying cabinet, the temperature of which automatically oscillates from 50 to 100°C forty times a day, which is equivalent to a few years' service in the factory. Their resistance was determined at different temperatures between 60 and 90°C by means of a paraffin oil thermostatic bath, a certified precision thermometer and a precision Wheatstone bridge with mirror galvanometer. It was found that the average resistance increase was 1% after two months' ageing, and lower than the reproducibility of the method (0·2%) during the third. The factor b from equation (3) was calculated and found equal to 4478°K for all thermistors, within experimental error. The mean resistance at 80°C was 99·300 ohms and all thermistors were within 6% of this value.

They were assorted in eight matched pairs of nearly equal resistance, which were used to build the instruments (three), and the nine others were rejected. According to the preceding theory each thermistor has to be associated in series with a high stability carbon resistor of 120,000 ohms.

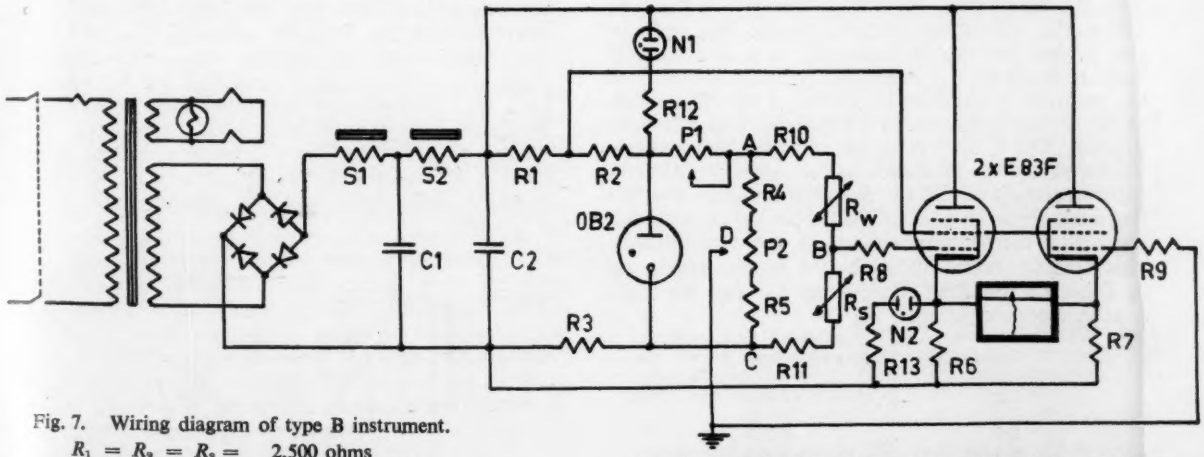

Fig. 7. Wiring diagram of type B instrument.

$R_1 = R_2 = R_3 =$	2,500 ohms	
$R_4 = R_5 =$	7,000 ohms	±1%
$R_6 = R_7 =$	12,000 ohms	
$R_8 = R_9 =$	1,000 ohms	
$R_{10} = R_{11} =$	120,000 ohms	±1%
$R_{12} = R_{13} =$	100,000 ohms	
$C_1 = C_2 =$	10 microfarads	
$S_1 = S_2 =$	10 henrys	
$P_1 =$	10,000 ohms	
$P_2 =$	1,000 ohms	

The instrument is assembled from standard radio components on an aluminium frame suspended on a vertical axis and enclosed in an iron cabinet made of welded sheet with a cast iron door. As the instrument must be installed in an ambient temperature

of about 40°C, all parts must be amply dimensioned and carefully selected for quality.

The heat-producing components (transformer, vacuum tubes, etc.) must be placed at the upper part of the frame, while the heat-sensitive components (capacitors) are located at the bottom.

The wiring diagram is shown in Fig. 7. The power supply comprises a selenium rectifier (Siemens SSF B250 C140) and two oil-filled capacitors (Fribourg) and supplies 250-volt filtered DC. The stabilizing tube is of the ionization type (Philips 0B2/108C1) and the two pentodes are guaranteed to have a 10,000 hours life (Philips E83F).

The heaters are fed in series in order that the failure of one tube would automatically stop the other. Two neon bulbs N_1 and N_2 are provided; their starting voltage (about 70) is selected so that they will glow only if the stabilizing tube and the cathode-follower stage are working properly. The recorder has a 1 mA full-scale deflection and a voltage drop of about 8 volts (Siemens SD12K).

The thermistor R_s (massecuite probe) is insulated by means of a glass-woven sheath and enclosed in a copper probe with welded radiating plates to ensure a fast temperature equilibrium. The thermistor R_w (steam probe) is enclosed in a Pyrex glass tube with a ground flat end, which is fitted in a brass base. The tightness is ensured by a synthetic rubber joint.

Before calibration the instrument is turned on for 250 hr to settle any unstable component (in particular the stabilizing tube). The voltage between A and C, when the potentiometer P_1 is short-circuited, is then measured by means of a high internal resistance voltmeter. This voltage is multiplied by the purity correction factors and the positions of the potentiometer P_1 corresponding to these values are pointed. The dial of P_1 thus becomes calibrated in purities. The purity adjustment is then put on 100, and the two probes are deeply immersed in a thermostatic bath at 80±0·05°C. After ten minutes the zero of the recorder is adjusted by means of P_2. The steam probe is then immersed in another thermostatic bath at 64·4±0·05°C and, after ten minutes, the intensity measured by the recorder—which corresponds to a supersaturation of 2·0—is noted (a resistor of a few hundred ohms should be added in series with the recorder if the pen happened to be out of the scale). This intensity is multiplied by the factors appearing in Table IX (deduced from Table VI) and the scale is calibrated accordingly.

Table IX. Scale Calibration.

S		
0·2	.....	0·060
0·4	.....	0·136
0·6	.....	0·226
0·8	.....	0·324
1·0	.....	0·427
1·2	.....	0·535
1·4	.....	0·648
1·6	.....	0·763
1·8	.....	0·882
2·0	.....	1·000

The supersaturation coefficients for various boiling point elevations taken from DUNNING's table II §3[4] were calculated with the help of TAYLOR's data. The instrument was checked by immersing each probe in a thermostatic bath at the corresponding temperature t_s or t_w and the supersaturation coefficients read were compared with the calculated values. The results are shown in Table X.

Table X

Verification of type B instrument against DUNNING's and TAYLOR's data

	t_s = 60°C			t_s = 70°C	
t_w	calc. *S*	read *S*	t_w	calc. *S*	read *S*
57·12	0·65	0·65	66·95	0·57	0·54
56·22	0·81	0·83	66·00	0·72	0·70
54·89	1·05	1·04	64·60	0·93	0·91
52·84	1·39	1·40	62·44	1·23	1·23
49·38	1·98	2·00	58·81	1·75	1·75
	t_s = 80°C			t_s = 90°C	
76·76	0·50	0·52	86·57	0·43	0·45
75·76	0·63	0·65	85·52	0·53	0·54
73·29	0·81	0·83	83·98	0·69	0·71
72·03	1·08	1·09	81·61	0·92	0·95
68·23	1·52	1·54	77·64	1·30	1·33

B. *Supersaturation-recorder type C.*

Twenty-five thermistors type B 2500 ohms/25°C were purchased from the same source and aged in the same way as for the type B instrument. The factor *b* was found to be 3233°K and the mean resistance 468 ohms at 80°C. They were assorted in six matched pairs of nearly equal resistance, and the thirteen others were rejected. According to the preceding theory (Table V) each thermistor has to be associated in series with a high stability carbon resistor of 1500 ohms.

The wiring diagram is shown in Fig. 8. The power supply is the same as for type B, except that the DC supplies is only 25 volts and roughly filtered. The printing galvanometer type recorder with parallel coils (Siemens List No. 509,256), although guaranteed by the manufacturer for currents–ratio measurements, failed to work properly and had to be replaced by a true crossed-coils indicating instrument (K. H. Weigand Messtechnik G.m.b.H., Erlangen, West Germany). The full-scale deflection of this instrument is 400 microamperes for an internal resistance of about 2000 ohms, and the directing coil current is 2·5 mA.

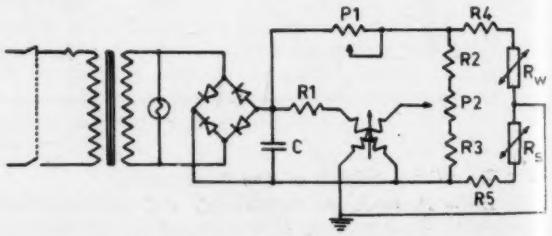

Fig. 8. Wiring diagram of type C instrument.

R_1 = 10,000 ohms
R_2 = R_3 = 100 ohms ±1%
R_4 = R_5 = 1,500 ohms ±1%
C = 100 microfarads
P_1 = 50 ohms
P_2 = 10 ohms

The calibration was made exactly as for type B and the instrument checked in the same way with analogous results except that a small zero drift of 0·05 was noticed between 60 and 80°C.

Installation

The instruments described are used to control the boiling operation in sugar manufacture, as it is generally agreed that the presence of crystals has no influence on the boiling temperature of a solution. The preceding theory can thus be applied without any alteration to slurries of crystals and syrup.

After the instruments had given complete satisfaction in 1-gallon size experiments in the laboratory, they were transferred to the plant, where they were tested in the actual boiling of refined liquors and raw syrups.

Perhaps the most difficult problem to solve was the installation of these instruments on boiling pans because both the boiling massecuite and the steam produced are superheated.

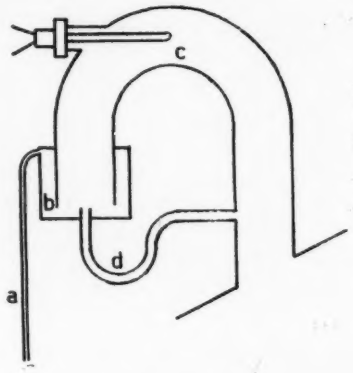

Fig. 9.

The massecuite probe must be placed as far as possible from the liquor inlet and at a rather low level because it must be submerged when the strike is grained. As the boiling proceeds, the massecuite level rises and a hydrostatic head of several feet occurs, which disturbs the boiling temperature unless there is sufficient mechanical circulation. This is not the case, particularly at the end of the strike. This drawback is common to all boiling point elevation instruments and has not yet been adequately solved, though several unpractical remedies have been proposed. The result therefrom is that an "apparent" supersaturation is recorded which does not correspond to the true saturation of the syrup. However, the departure from the actual supersaturation is sufficiently reproducible to permit an efficient control of the boiling.

The steam probe is fitted in a device schematically represented in Fig. 9, which is designed to produce saturated steam at the pressure prevailing in the boiling pan. A small flow of low-pressure steam (7 p.s.i.) is expanded to the pressure prevailing in the boiling pan by means of a needle valve and led to the separator *b* through an uninsulated copper pipe *a* which is about 10 ft long and where the steam is partly condensed. The entrance of the separator *b* is tangential and the condensed water is discarded in the pan through the siphon *d*, while the steam passes through the bend *c* in which the steam probe is fitted. The separator *b* and the pipe *c* are insulated to prevent any further condensation of the saturated steam. This system has worked for several months without any attention. Steam pressure and flow rate are not critical.

Before putting the instrument into service, the zero must be adjusted by boiling water in the pan under slightly reduced pressure, so that the water boils at about the usual temperature for syrup boiling. A large departure from the laboratory adjustment is a sign that there is something wrong in the saturated steam device.

Owing to its principle, the instrument is unaffected by slow pressure changes in the boiling pan and no pressure regulation is needed. However, sudden variations cause a false reading of supersaturation on account of the difference between the "time constant" of the boiling massecuite and that of the vapour device. This can be smoothed by sleeving on to the end of the glass tube containing the thermistor a piece of suitable insulating material, the thickness of which is experimentally adjusted as to smooth out the sudden temperature changes of the steam probe. Such a correction can, of course, only be approximate, as the volume of the massecuite is not constant.

When a supersaturation recorder type B is installed, the greatest care must be exercized on the insulation of the wires between the probes and the instrument, as any leak lower than 20 megohms will disturb the readings.

Acknowledgment

The author is indebted to G. A. Naveau for suggesting the use of Spengler's boiling point elevation data; to A. Gilson for the design of the device to measure the temperature of saturated steam; and to the Raffinerie Tirlemontoise S.A. for permission to publish this work.

Italian Beet Production, 1957.[1]—About 5,900,000 metric tons of beet were produced in Italy last year, compared with 7,054,500 metric tons in 1956. The area sown was about 220,000 hectares compared with 224,769 in 1956.

* * *

New Chilean Factories.[2]—In addition to the factory at Llanquihue[3] and Linares[4] it is reported that work will shortly commence on a plant at Temuco. It is planned eventually to have a chain of ten factories which, it is hoped, will render imports of sugar into Chile unnecessary.

[1] F. O. Licht, *Int. Sugar Rpt.*, 1957, **89**, (11), 9.
[2] C. Czarnikow Ltd., *Sugar Review*, 1957, (332), 209.
[3] *I.S.J.*, 1957, **59**, 344. [4] *Ibid.*, 212.

THE SUGAR INDUSTRY IN PAKISTAN

By Dr. H. KAMPF, Dr.Tech.Sc. (Vienna), F.R.I.C. (London)

PAKISTAN'S production of white sugar from cane was only about 30,000 tons ten years ago at the time of the partition of British India. Since then the cane sugar industry has made rapid progress, as can be seen from Table I, which covers the crushing seasons 1951/52 to 1956/57.

Table I

Season	White Sugar Production (tons) East Pakistan	West Pakistan	Pakistan Total	White Sugar Import (tons)
1951/52	39,527	29,712	69,239	151,200
1952/53	30,856	47,666	78,522	30,000
1953/54	27,633	48,751	76,384	70,000
1954/55	46,695	40,450	87,145	82,500
1955/56	47,084	56,092	103,176	97,500
1956/57	31,319	75,751	107,070	—

Season	Crushing Capacity (tons cane/24 hr) East Pakistan	West Pakistan		Number of Sugar Mills East Pak.	West Pak.	Total
1951/52	3700	4450	..	5	3	8
1952/53	3700	4450	..	5	3	8
1953/54	3700	4450	..	5	3	8
1954/55	3700	6850	..	5	5	10
1955/56	3700	6850	..	5	5	10
1956/57	3700	8350	..	5	6	11

Although during the 1956/57 crushing season the sugar factories in Pakistan had a record output of 107,070 tons of white sugar, the country will still have to import about 75,000 tons. Sugar is still rationed and strictly controlled in Pakistan, consumption being thereby kept down to only 180,000 tons a year, which includes the sugar required by industrial consumers such as manufacturers of jam, confectionery and soft drinks. If white sugar were to be de-rationed and freely available, the actual requirements per year would rise to 280,000–300,000 tons. Thus the Ministry of Food, which is still the sole importer of sugar, would have to import 175,000 to 200,000 tons of sugar.

Fig. 1. Premier Sugar Mills, Mardan.

At present there are six cane sugar mills operating in West Pakistan and five in East Pakistan. The total production capacity of these eleven factories is theoretically 125,000 tons of white sugar per annum, although the record output in 1956/57 was only 107,070 tons.

The old-established sugar mills in West Pakistan are the Gujranwala, the Frontier and the Premier Sugar Mills; those in East Pakistan are the North Bengal, the Setabganj, the Carew & Co., the Deshbandu and the Kishwarganj sugar mills.

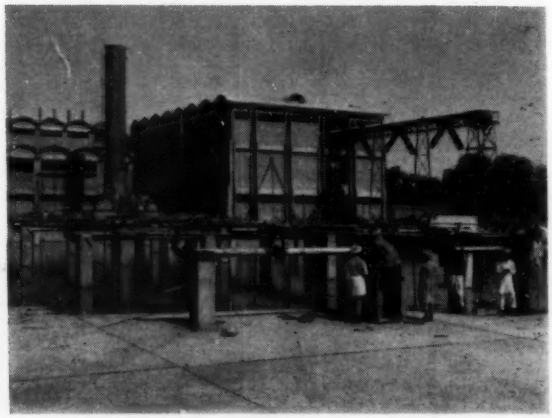

Fig. 2. Charsadda Sugar Mills, Charsadda.

These eight factories worked up to full capacity during season 1956/57. The largest is the Premier Sugar Mills & Distillery Co. Ltd. at Mardan (Fig. 1). The plant was supplied by George Fletcher & Co. Ltd. (Derby), and the erection was completed in 1950. The crushing capacity is 2800–3000 tons of cane per day, with provision for the installation of additional plant to increase the throughput. The Premier mill contributes rather more than one-third of the total production of white sugar in both wings of Pakistan, as shown in Table II.

Table II

Season	Premier Sugar Mills: Cane crushed (tons)	Sugar made (tons)	Pakistan: Sugar made (tons)
1950/51	103,192	8,617	—
1951/52	213,499	18,547	69,239
1952/53	452,166	31,585	78,522
1953/54	410,551	32,078	76,383
1954/55	363,252	23,298	87,145
1955/56	344,365	30,124	103,175
1956/57	478,337	34,544	107,070

During the last five years the Pakistan Industrial Development Corporation (Karachi) has been largely influential in the development of the country's sugar

ndustry. Since 1952, when the Company was estab-shed, three new sugar factories in West Pakistan ave been sponsored by the Corporation and quipped with machinery supplied by Messrs. A. & V. Smith & Co. Ltd. (Glasgow) and by Maschinen-brik Buckau R. Wolf A.G. (Grevenbroich). Two f these factories, situated in Leiah and Jauharabad, tarted production of white sugar in 1955/56, and he third in Charsadda in 1956/57 (Fig. 2). A fourth ctory is under erection in Rangpur, East Pakistan, nd is scheduled to go into operation during the 957/58 season. Machinery for two more factories n East Pakistan has been ordered by the Pakistan ndustrial Development Corporation from the same uppliers in the U.K. and Germany, and will be erected in Thakurgaon and Dewanganj in 1958.

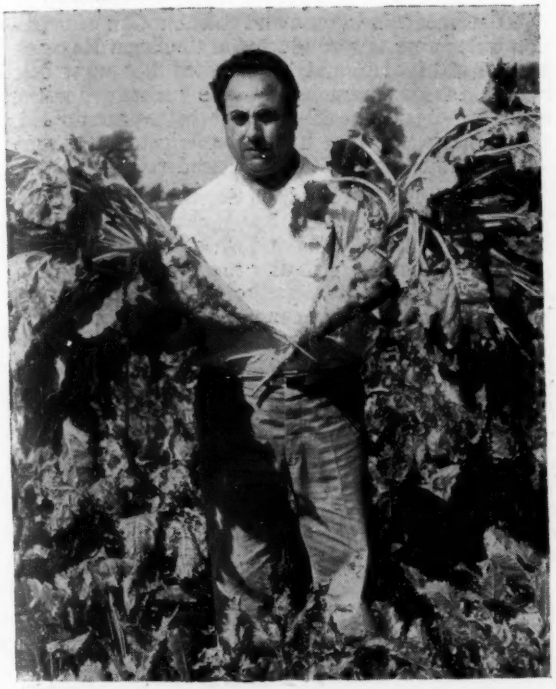

Fig. 3.
Mr. OBAIDULLAH JAN (Sugar Cane Specialist) with sugar beet grown at the Sugar Research Station, Mardan.

The three mills in Leiah, Jauharabad and Charsadda (West Pakistan) produced together little more than half the expected quantity of sugar in 1956/57; but it is hoped that, in 1960, when all six new mills will have reached their targets, the home production of sugar in Pakistan will be about 160,000 tons. Assuming a consumption of 280,000 tons of sugar in 1960, there will still be a deficit of 120,000 tons which will have to be filled by imports from abroad, requiring foreign exchange to the value of about 60m Pakistan rupees.

Although the devaluation of the Pakistan rupee to parity with the Indian rupee in August 1955 stimulated the export of jute, cotton, hides, skins and tea, and the country's new manufacturing industries expanded their sales overseas, there is still a great shortage of foreign exchange. Restrictions on imports have been continued.

The Pakistan Central Government is very much interested in the economic development of the country and has decided to appoint a Sugar Commission consisting of six or seven members. The terms of reference will be wide and comprehensive, ranging from problems of sugar cane production and the expansion of the sugar factories to the price and distribution structure of sugar. In this connexion, it is significant that the Central Government, before the intended appointment of a Sugar Commission, came to the decision to explore the possibilities of a beet sugar industry in Pakistan, to enable the country to produce enough sugar for her own requirements.

As early as 1912, W. R. BROWN, Agricultural Officer of the former N.W. Frontier Province of Pakistan, successfully carried out experimental growing of sugar beet in the Peshawar Valley. Dr. LEATHER, ex-Agricultural Chemist of the Imperial Institute of Agricultural Research, in 1915 analysed some of the beets and found an average sucrose content of 14%. Further trials were made with sugar beet at the Agricultural Research Station, Tarnab, near Peshawar, from 1936 until 1941, when, because of the second world war, the import of sugar beet seed from abroad was not possible. After the establishment of the Sugar Cane Research Station at the Rakh farm, Mardan, in 1950, experiments on the cultivation of sugar beet were renewed in a scientific and methodical manner. The results of the research work during the last seven years under the guidance and control of Mr. MIAN OBAIDULLAH JAN, Sugar Cane Specialist (Fig.3), confirmed the earlier findings that the climate and the soil in many areas of the Peshawar Valley is suitable for the cultivation of sugar beet. Encouraged by the experience of the Research Station and the satisfactory results obtained with a small sugar beet plot at Mardan, the Premier Sugar Mills imported, with the permission of the Government of Pakistan, sufficient sugar beet seed ("Kleinwanzleben E") to plant about 250 acres of land with beet in September and October 1957.

While sugar beet is sown in England and on the Continent at the end of April and the harvest starts usually in September, the results of the seeding and harvesting trials at the Sugar Research Station at Mardan have shown that in North-West Pakistan sowing should be done in the months of September October and November. Harvesting of the ripe beet may begin after the middle of April but should be completed before the start of the hot season in the middle of July.

The cane crushing season in North-West Pakistan lasts six or seven months. The sugar cane is normally harvested from November till the end of May. As the sugar beet will be mature in May and can be harvested till mid-July, the sugar season could be prolonged by 2–2½ months, after the existing cane

sugar mills in North-West Pakistan have been equipped with the additional beet shredding and diffusion plants. The growing of the required sugar beets would fit in evenly with the agricultural economies of the factory areas.

Experiments carried out not only by the Sugar Cane Research Institute, Mardan, but also by several local cane cultivators, have proved that yields of 16·5–18·4 long tons of sugar beet per acre can easily be obtained in the Peshawar region. After the growers have gained more experience in the cultivation of sugar beet, yields of 25·7 tons per acre will be possible, but for the present we assume only a yield of 16·5 tons per acre.

During three consecutive cane crushing seasons the sugar beet grown for experimental purposes in and around Mardan has been put through the cane mill together with sugar cane (Fig. 4). This experiment was first successfully tried at the Premier Sugar Mills on 20th May 1955. Cane and beet were shredded and milled together in the proportion of 85:15. In the later trials in the 1955/56 and 1956/57 seasons the ratio was altered to 80–77% cane and 20–23% beet. The first experiments were done with cold imbibition before the sixth mill, but on 10th May 1957 hot imbibition water (140°F) was successfully used in order to reduce the sugar losses in the bagasse–pulp mixture. In all experiments the juice mixture from cane and beet was paler than the usual mixed juice from cane. The Premier Sugar Mills uses the de Haan double carbonatation process for the production of white sugar. During the combined processing of the cane–beet mixture only the dose of milk-of-lime had to be slightly increased. No difficulties were experienced in the clarification and press house, and the extracted sugar was of the normal good quality. During the experiment in May 1957 the processed sugar beet gave a factory yield of 11·53%, while the sugar cane, milled at the same time, had a recovery of only 6·62%. No doubt, with a proper diffusion plant, the recovery of the beet sugar would have been much higher.

Fig. 4.
Sugar Cane and sugar beet before combined milling.

As the sugar content of the beet sown in October and harvested in May averaged 15·5%, we can assume, in a comparison of the economics involved in the extraction of sugar from beet and cane that, during the introductory period the average recovery from beet will be at least 13%. Regarding the sugar cane in the Mardan district we know from experience gained during the last seven seasons that the average yield may be taken as 12·86 tons of cane per acre with a factory recovery of 7·75%.

The above figures disclose that whereas the total sugar per acre under beet is about 4800 lb, the total sugar per acre from cane, even assuming optimistically a recovery of 9% in the factory and a yield of 14·7 tons of cane per acre, will be only 2960 lb. It is evident that the beet sugar industry could profitably be established in N.W. Pakistan.

Experiments in the use and consumption of irrigation water were also conducted at the Sugar Research Station at Mardan, and have shown that sugar beet requires a maximum of 50 acre inches of water, while for sugar cane 90–100 acre inches are needed. Furthermore, the beet has to be irrigated at a time when no other crops in the fields need irrigation water.

A unique method has been developed by the cultivators in N.W. Pakistan. For generations they have successfully planted cane and wheat in the same field at the same time. A similar method has now been adopted by the Sugar Research Station for a combined planting of sugar cane and sugar beet in one and the same field. The cane is planted in October in furrows and between the rows of cane the sugar beet seed is sown. The beets are harvested in the following Spring and at a time when the cane is not yet very high. The cane grows during the summer months and can be harvested as from November. This system produced about 6580 lb of sugar per acre a year from both crops, while sugar beet or sugar cane gave only 4800 and 2470 lb of sugar, respectively, when grown in two separate fields.

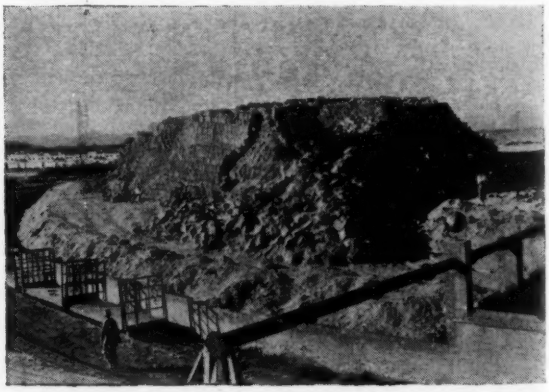

Fig. 5.

Approximately 40,000 tons of surplus bagasse at Premier Sugar Mills, Mardan.

It will have been seen from the information above that there is scope for development of a beet sugar industry in N.W. Pakistan. Instead of importing white sugar from overseas, beet sugar could be made from beets grown in the Mardan district and the sugar extracted in one or all the existing cane sugar mills if the Pakistan Government would consider the granting of the necessary foreign exchange for the purchase of the additional beet sugar machinery.

Of all the cane sugar mills in Pakistan only the Premier Sugar Mill generates steam sufficiently economically to give a regular surplus of bagasse, about 30,000 tons having remained at the end of the past four cane crushing seasons (Fig. 5). Thus no imports of coal or oil would be required, as a part of this surplus bagasse—which has become a disposal problem—could be utilized as fuel to run the factory during the beet sugar season.

Since the sugar content of the sugar beet cultivated in the Mardan area is about double the sucrose content of the locally grown sugar cane varieties, the Premier Sugar Mill, which is designed to cope with the sugar from about 2800–3000 tons cane per day, would require only a beet-washing—shredding—diffusion plant to deal with 1500 tons of sugar beet per day. The clarification, sugar boiling and centrifuging could be carried out with the machinery already installed, after completion of a moderate expansion. In 1956/57 the Premier Sugar Mills produced nearly 35,000 tons of sugar from cane. Where the mill is equipped with suitable machinery to process during a 60–70 days season about 90,000 tons of beet, the production of sugar therefrom can be estimated at 20,000–25,000 tons. In a few years the savings in foreign exchange will more than compensate for the cost of the import of the necessary machinery to establish this unit.

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FUTURE UTILIZATION OF SUGAR CROPS

By H. B. HASS (President, Sugar Research Foundation, Inc.)

Paper presented to the American Chemical Society, New York Meeting, September 1957.

UNDOUBTEDLY sugar will continue to be used as a major source of energy in the diet of humans and of domestic animals. For the foreseeable future this will be its major utilization. The increasingly rapid growth of the world population is dramatically expressed in the simple statistic that today, on the average, there are 110,000 more mouths to feed than there were yesterday[1]. Sugar cane and sugar beets give more food energy per acre-year than any other major crop. Assuming the availability of at least adequate amounts of the other necessary dietary factors, it seems inevitable that more and more sucrose will be produced and eaten.

The conversion of the by-products of sucrose to such useful foods as meat and milk is already an important aspect of our agricultural economy. Virtually all beet pulp (extracted beet slices) and tops are fed to cattle. Recent improvements in the ammoniation of beet pulp have been reported elsewhere, and three patents have been issued—in Belgium, Turkey and France. We seem to be on the verge of an important industrial development here.

Ammoniated bagasse pith has also proved to be of value in the nutrition of ruminants, although present indications are that pith–urea–molasses mixtures are even better.

The industrial growth of ethanol, butanol and acetone from the hydrocarbons of petroleum and natural gas has replaced much of the material formerly made from molasses. This has freed molasses for use in stock feed, where it is of greater value. We can see no prospect of a reversal of this trend prior to the time, still in the distant future, when hydrocarbons will be scarce and expensive.

Eventually, we shall be forced to produce all of our organic chemicals from continually renewable resources such as sugar and the carbon dioxide of the atmosphere. Meanwhile it is clear that two fairly well-defined areas exist; for the simple molecules petroleum is the proper source, and for more complicated ones, we turn to plants or even animals.

The New Fermentation Industries

While ethanol from molasses is a dying industry —except for rum—and the butanol-acetone fermentation has been discontinued in the United States, citric acid continues to grow and has thus far not been threatened by petrochemicals. It could be made from propylene through acetone, but the process would be uneconomical.

Aconitic acid is recovered from cane molasses where it occurs naturally. Itaconic acid is made

[1] *Scientific Monthly*, 1957 (Sept.), 114.

commercially by fermentation using *Aspergillus terreus*. Kojic acid and lysine are also made by special fermentations. Lysine can be made in a variety of other ways, but only the laevorotatory form is used by the body in the synthesis of proteins and so the fermentation product has a 2:1 advantage over the synthetic acid.

By the hydrolysis of the protein of beet molasses residues one obtains glutamic acid. Its monosodium derivative is a major and rapidly growing condiment which imparts a salty-meaty taste to soups, fish, meats and vegetables.

The antibiotics are, with one or two exceptions, all made by fermentations from carbohydrate starting materials even when their structure has been determined and their laboratory synthesis achieved. Again it is a question of relative costs.

Glycerol by fermentation seems obsolete although some optimists are still hopeful. If glycerol is made from sugars it will presumably be by hydrogenolysis.

The newest fermentation product is the plant growth stimulant giberellin. Here again is a molecule whose commercial synthesis seems quite remote. Its production by fermentation was announced only a few months after it began attracting the interest of gardeners. A new field seems to be opening here.

It seems clear that the continued growth of the fermentation industries will yield more and more of the complex molecules so necessary in modern medicine. Perhaps gibberellin and/or its relatives will be of great importance to the future of agriculture.

High Polymers

This field covers adhesives, rubbers, plastics, fibres, surface coating compositions and soil conditioning agents. Most of such materials are now made from petrochemicals, except for cellulosic derivatives. These, however, constitute our principal fibres and cellulose acetate, acetate butyrate, cellulose propionate, ethylcellulose, methylcellulose and carboxymethylcellulose are of substantial importance. It may now be stated quite positively that not only paper, but also dissolving pulp for cellophane and rayon, can be made satisfactorily from bagasse. There is no reason known to the author why the other cellulose derivatives might not be made from bagasse.

The manufacture from bagasse of building board, of both high and low density, is too well-known to require more than mention here. This is rapidly expanding in the tropics. Much synthetic rubber has been made from molasses via ethanol and butadiene, but this is in the area of the simple molecules where petrochemicals reign supreme.

Methyl acrylate polymer has been made from sugar via lactic acid, but the present process using acetylene, carbon monoxide and methanol seems secure.

The recent announcement[2] that as much as 50% of sucrose can be incorporated in phenolformaldehyde resins while they are being formed, with improvement in colour and only a slight change in other properties, is of great interest. This was foreshadowed in 1934 by EMIL LOETSCHER[3] but the newer development has carried his work further.

The condensation of bagasse with phenols and aromatic amines in the presence of sulphuric acid was discovered by work at the Northern Regional Research Laboratory, Peoria, Illinois, and is being exploited commercially by the Valite Corporation, New Orleans, Louisiana.

The conversion of sugar cane bagasse to furfural by action of dilute sulphuric acid is now an established industry. The furfural goes to nylon via furan, tetrahydrofuran, 1,4-dichlorobutane, hexanedinitrile and 1,6-diaminohexane.

Hydrogenating sucrose in the presence of excess ammonia results in the formation of a family of diamines, including ethylenediamine, propylenediamine, and 2-methylpiperazine. These bifunctional compounds are suitable for the synthesis of polyamides.

Sucrose combines readily with up to 8 moles of propylene oxide to yield an adduct (still containing eight hydroxyl groups) suitable for producing cross-lined isocyanates[4].

The conversion of sucrose to dextrans of various types has been most thoroughly investigated. Currently, dextran is being tested as an ingredient of drilling muds for oil wells where its principal function is to increase viscosity. If this work is successful, the by-product, fructose, will be obtainable in sufficient quantity to test the market for this sweetest sugar which, in pure form, has never been available at a competitive price. Dextran lends itself to the synthesis of a great variety of esters and ethers which are of possible use as plastics if they are not too expensive.

There are a great many other possible ways of making water-soluble gums from sucrose. None of these has been adequately investigated so far as the literature records. Work is actively under way in this field by Sugar Research Foundation Inc.

The hydrogenation of invert sugar to mannitol and sorbitol, and the use of these materials in alkyd resins, is still another way of converting sucrose to high polymers. The use of sucrose directly in alkyds is unsuccessful because of caramelization.

Itaconic acid esters are valuable cross-linking agents for vinyl polymers.

Drying oils may be made from sucrose by forming the polyallyl ether using allyl chloride and a base. They are too expensive because of a yield of only 60% of theory.

Another procedure is to condense methyl esters of drying oils with sucrose liberating methanol and forming superior drying oils. Both of these are being actively investigated.

Soil conditioning agents, while effective, have proved to be too expensive for wide use. A "flash of genius" might some day discover how to start with a cheap material, such as sugar cane bagasse.

[2] *Chem. & Eng. News*, 25th March 1957.
U.S. Patent 1,959,433.
Chem. & Eng. News, 17th June 1957, 88.

nd by a relatively simple operation form a good oly acid which would function as an effective and conomical soil conditioner.

The whole problem of high polymers from sucrose nd its by-products seems to have been inadequately nvestigated. There is room here for a vast amount f fruitful research effort. It is unnecessary to point ut that high polymers are a very large and actively rowing industry. They must some day be based on enewable resources.

Detergents

At present over two-thirds of the soap and detergent business in the United States goes to detergents. This is a preview of what will probably happen in the rest of the world, and there is no evidence that soap will hold even its present 32% of the market. To the extent that fats are reduced to higher alcohols and sulphated, some of this market is retained for chemurgic raw materials. The alkylaryl sulphonates, however, are derived from petroleum, as are the ethylene oxide derivatives.

Recently the mono and di fatty acid esters of sucrose were announced. These are, when pure, colourless, odourless, almost tasteless, non-irritating solids which are edible, digestible, nutritious, excellent detergents and emulsifying agents, and are potentially low in cost. The ten present licence agreements covering the process and product are operative in Argentina, Brazil, Denmark, France, Italy, Mexico and the United States. Others are being negotiated

Dow recently announced a new family of synthetic detergents which are fatty acid esters of the adduct obtained by treating sucrose with 8 moles of propylene oxide.

A great many other ways of making surfactants from sucrose remain to be investigated. The market research group of Foster D. Snell Inc. have estmated that within ten years world production may be 2·5 million tons per year of detergents made from sucrose. If so, this would comprise a major chemical development.

Fuels and Explosives

The principal use of bagasse is to be burned under the boilers to raise steam for operating the sugar mill. It is potentially too valuable for this, and already we can see more and more bagasse going into paper, building board, poultry litter and furfural. Eventually the value of bagasse pith in animal feeding, the abundance of nuclear energy and the demand for cellulose products must conspire to decrease the burning of bagasse.

Sucrose octanitrate is sometimes a constituent of dynamite when glycerol and glycol are scarce. It has not been used for some years. Mannitol hexanitrate obtained by hydrogenating invert sugar and nitrating the resulting mannitol has a secure place in primer cops. A little bagasse pith is used in the formulation of low-density dynamites.

The co-product of the hydrogenation of invert sugar is sorbitol, which finds a great variety of uses as a precursor of ascorbic acid, a humectant, food ingredient, and intermediate for the synthesis of surfactants appearing under the trade-marks "Spans" and "Tweens". Most sorbitol is made from dextrose rather than invert sugar.

Solvents and Plasticizers

At one time a high proportion of our solvents, such as ethanol, butanol and acetone, was made from sucrose or invert sugar in the form of molasses. These simple molecules will be made from hydrocarbons in the foreseeable future.

Plasticizers are essentially high-boiling solvents. Here the molecules are more complex and there is a possibility that sucrose esters may be of importance. They are being investigated by Sugar Research Foundation Inc.

Pesticides

Sucrose is very readily absorbed by both plants and animals. Battelle Memorial Institute is attaching various toxiphoric groups to sucrose. Some of these materials have modified and interesting properties. Much remains to be done here since new toxiphores are continually being discovered.

Waxes

Cane wax has a history of having been on and off the market, depending upon the price of competing waxes. The Sugar Cane Wax Enterprise, owned jointly by the Cuban-American Sugar Co. and S. C. Johnson & Son, has, by thorough research, developed this material to the point of commercial success. Cane wax requires no hand labour beyond that used in any case to produce sugar. As labour costs move upward, it has an inevitable advantage over its competitors, which depend on cheap workmen. The potential supply of cane wax is immense; the limiting factor is demand.

Adhesives

An agricultural sticking agent of value in causing insecticides and herbicides to adhere to the leaves of plants can be obtained by treating sucrose with various aldehydes in the presence of sulphuric acid. The product is a mixture of the acetals of sucrose and invert sugar[5]. The sucrose–phenol–formaldehyde and sucrose–resorcinol–formaldehyde appear to be very good as plywood adhesives.

Conclusions

This brief survey of the present status of sucrochemistry leads inevitably, the author believes, to the conclusion that much clever and intelligent research has already been done in this field. Many fruitful approaches have been discovered. The opportunity for further research of great economic value seems unusually large in comparison to the effort up to now, a view shared by the research organizations of many of the most respected American chemical companies.

[5] R. J. BAIRD: U.S. Patent 2,702,249; 15th February 1955.

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AN APPARATUS FOR QUALITY "GRADING" OF WHITE GRANULATED SUGAR

By Wm. H. PARKER, M.Sc., and G. M. BOND
(Chemical Control Service, British Sugar Corporation Ltd.)

ONE of the most important—if not the most important—features to the manufacturer of pure white granulated sugar is that his product is up to the standard in appearance which he requires it to be. This applies particularly to sugar produced for domestic consumption, where it appears every day under close and critical scrutiny by all who partake thereof.

The general practice in the sugar industry is to "grade" sugar by comparing visually samples with accepted standards in order of "whiteness". The result, known as the "visual grade", will be seen to depend entirely upon the judgment of the individual making the test. In addition to the effect of the human element the result depends upon the efficiency of the lighting and the general conditions under which the tests are made, which cannot be standardized completely in every detail.

It should be pointed out here that the differences between grades are so very small as to be detected only with the greatest difficulty with the naked eye.

Quite frequently samples were found to be better than one grade and not quite up to the standard of the next higher grade and, although each group was sub-divided, the difficulty was not entirely overcome.

Some means was sought, therefore, of using the light reflected from the surface of a sugar sample to measure its grading optically. Accordingly, the National Physical Laboratory were approached for their views, with the result that their Light Division tested standard samples of sugar in the spectrophotometer. A relatively large change of reflectance occurred at the blue end of the spectrum indicating the possibility of using a photocell to discriminate between the various grades through a blue filter.

The curves reproduced below show the reflectance factor of a flat surface of the sugar samples tested relative to that of a similar surface of pure magnesium oxide. At each wavelength the total radiation reflected in all directions was evaluated. The samples were contained in a glass cell of rectangular section, the measurements being made with the sample surface vertical. The incident light accordingly had to pass through the flat wall of the cell.

To compensate for possible selective absorption in the glass of the cell, two similar pieces of glass were inserted in the reflectance beam falling on the MgO surface used as the standard for comparison.

The compensating glasses have the further effect of causing higher reflective values to be recorded than would be obtained if the uncovered sugar surface were compared directly with MgO. The increase is offset to some extent because of inter-reflections which take place between the sugar surface and the glass wall of the cell, but there remains a nett increase attributable to these two effects of the order of 10%. The increase should be approximately independent of the wavelength. These effects partly explain the values of 100% obtained at $\lambda \geq$ 560 mμ for Sample No. 1.

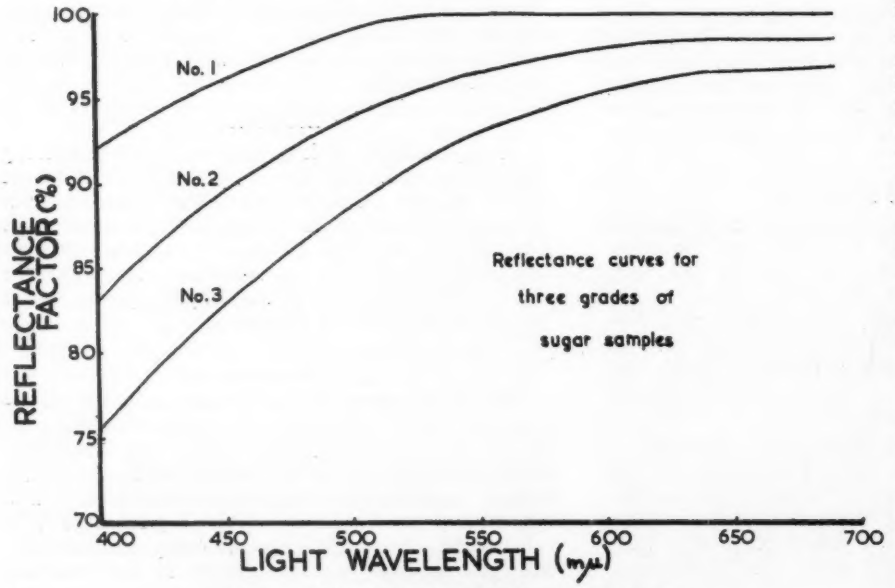


Fig. 1. Spectrophotometer Grading of White Sugar.
(Reproduced by kind permission of the Director of the National Physical Laboratory).

The foregoing considerations have been used as the basis for developing the apparatus, known as the "Spaldinlab" white granulated sugar grader, about to be described.

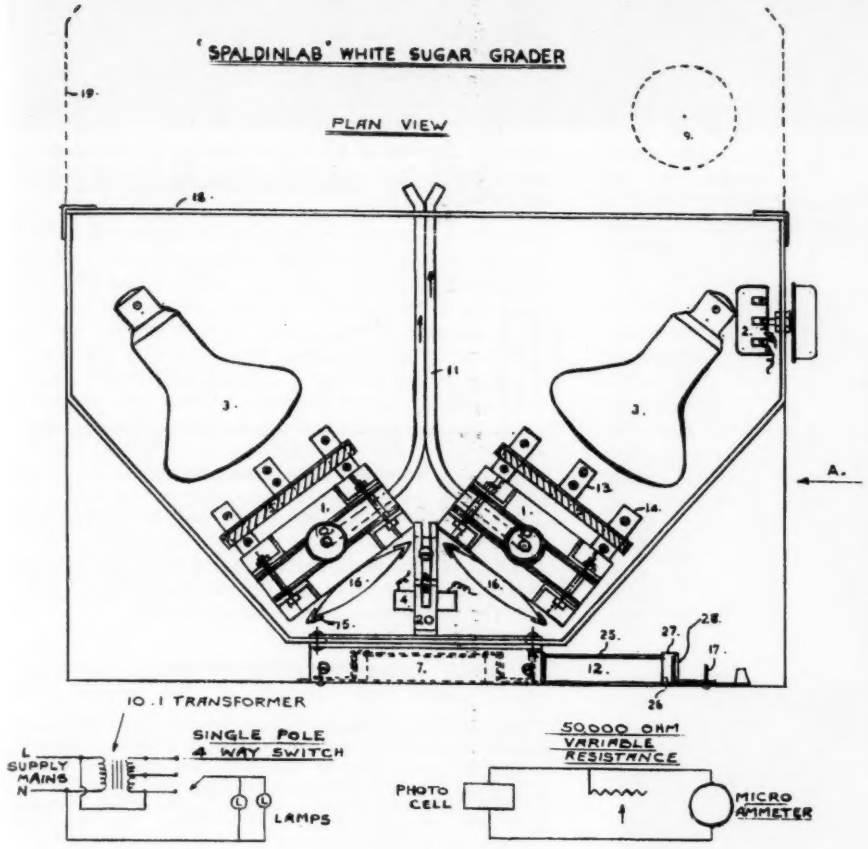
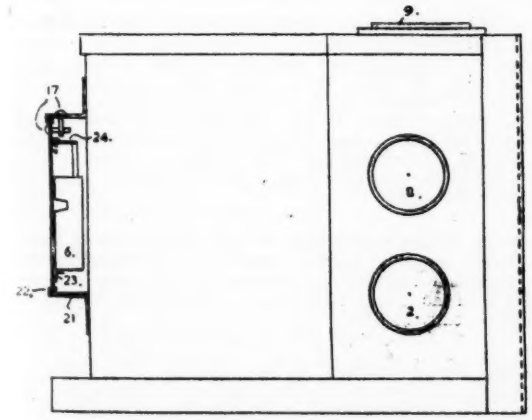


Fig. 2

KEY

1. Copper sulphate cells
2. Max. sett. potentiometer
3. Floodlamps
4. Selenium photocell
5. Heat filter
6. Slide
7. Magnesium oxide cell
8. Light switch
9. Microammeter
10. Glass funnels
11. Rubber tubing
12. Sugar cell
13. Filter supports
14. Main cells supports
15. Lens brackets
16. Lenses
17. Stop pins
18. M.S. case
19. Cover
20. Photocell bracket
21. Slide angle 1″×1″
22. Slide channels $\frac{1}{8}$″×$\frac{1}{8}$″
23. Slide angle $\frac{1}{4}$″×$\frac{1}{4}$″
24. Sugar cell swing clips
25. Cell glass plate
26. Cell's ebonite frame (part)
27. Cell's frame bracket ($\frac{1}{4}$″×$\frac{1}{4}$″ angle)
28. Slide angle 1″×$\frac{3}{4}$″



ELEVATION A.

The first experiments used a Germanium photo-cell for comparing standard samples with powdered magnesium oxide. Whilst the curve for Sample No. 3 was better than that obtained in the N.P.L. tests, the first two grades gave curves which were only slightly better than this. Selenium photo-cells were then tried, together with various light filters. Different light sources also were tried—mercury vapour, mercury and tungsten, and plain tungsten. The last was chosen on account of lower cost, availability, cooler running, and speedy attainment of full brightness after switching on.

A cell containing a 10% copper sulphate solution was used as a light filter because it was found to give a better light transmission than other filters at the desired wavelength.

Some trouble was experienced with voltage drops on the mains supply. Tungsten lamps must be over-run to produce sufficient light at 400 mμ and a 10-volt drop in the mains supply cuts down the output of the photo-cell to about one-half. To avoid the use of a costly constant-voltage transformer, it was decided to boost the mains in steps by means of a cheap transformer to a point where the voltage was just in excess of that required and to correct the full-scale reading when viewing MgO by means of a variable shunt across the meter. A constant voltage supply is essential to ensure consistent results.

The above drawing shows the general arrangement with a wiring diagram.

As will be seen, the light from the mirror-backed lamps passes through heat filters, thence through the copper sulphate solution. The lenses focus the emerging beam on to the face of the sample under test at an angle of 45°. The reflected light is received by the photo-cell, which is covered by a deep violet filter and is set back some 2 inches and is parallel with the sugar cell. The output from the photo-cell is registered on a micro-ammeter with a full-scale deflection of 50 μamps calibrated in 0–100 scale divisions for direct reading of grade numbers.

The apparatus is simple and quick in use. A sample can be "graded" in the course of a minute or so. The procedure is as follows:—

The comparator cell remains permanently filled with MgO powder. The sample cell is filled with the sample of sugar under test and is replaced in the slide. The control knob (Item 2 on the side elevation drawing) is turned fully clockwise to the stop. The upper knob (Item 8) switches on and is then turned in steps until the meter is in excess of the full scale. The control knob (Item 2) is then adjusted to read 100 divs. on the scale to standardize the apparatus. The slide is then pushed in so that the sample cell occupies the "viewing" position formerly occupied by the MgO standard cell. The

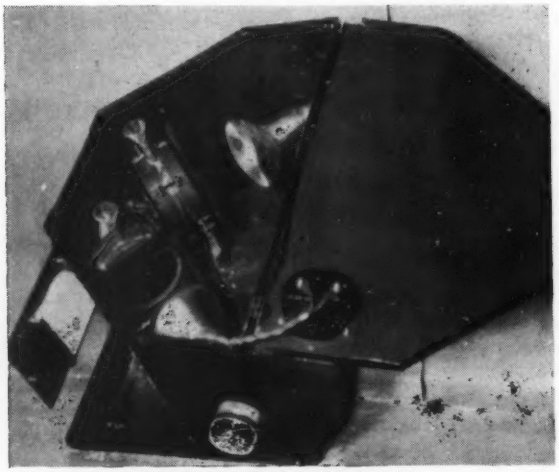


Fig. 3.

View showing Sample Slide and Interior (lid open).

reading in the meter gives the reflectance value, which is the grade number. The results are repeatable to ±1%.

Some tests recently made on standard white sugar samples gave the following values:—

Sample No.				
1	....	94·5	....	94·4
2	....	90·4	....	90·4
3	....	86·3	....	86·4
4	....	82·4	....	82·4

It should be mentioned that grain size has an appreciable effect on reflectance values so that standards have to be selected according to the size of grain of the samples to be tested. The advantages of having such a very sensitive apparatus which will discriminate between the extremely small differences in degrees of whiteness that are involved giving numerical values and eliminating the human element are obvious.

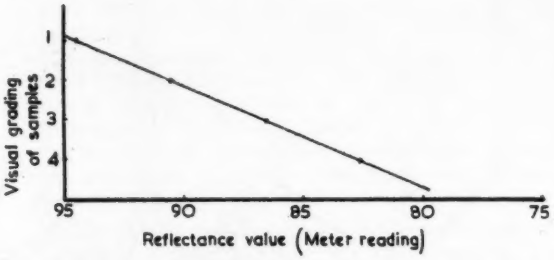


Fig. 4. Reflectance Values for White Sugar Standards.

The authors wish to express their thanks to the Executive Directors of the British Sugar Corporation Ltd. for permission to publish this work.

Australian Sugar Machinery.[1]—Australian sugar machinery manufacturers are making a bid to supply heavy machinery to South Africa. A director of Associate Engineering Manufacturers of Australia (Pty.) Ltd. has been conducting a survey of South African needs and is quoted as stating that Australia could offer complete sugar mills at prices that compared favourably with those from the U.K., U.S.A. and Germany.

* * *

St. Kitts (Basse Terre) Sugar Factory Ltd. 1957 Report.—Crop started on 5th February, but as a result of very severe drought the out-turn was only 44,794 tons of sugar from 363,165 tons of cane, which represented a drop of over 10% of the estimated figure. Sugar for export amounted to 40,243 tons, of which 29,535 tons were sold to the Sugar Board under the Commonwealth Sugar Agreement and the balance on the free market. The outlook for next crop is not good as the new cane cannot entirely recover from the effects of the drought.

* * *

Central African Federation.[2]—A new factory costing about £1,000,000 is to be built at Ndola in the Federation of Rhodesia and Nyasaland. Construction will not be completed until the end of 1959, but it is hoped that production will begin early in 1960.

* * *

Indian Futures Markets Recommendation[3].—The Forward Markets Commission of the Government of India submitted its report recently, in which it recommended, *inter alia*, that futures markets in sugar be established at Kampur, Muzaffarnagar and Bombay, and that the present restrictions on the forward sales of sugar by mills in advance of quota releases as well as the periodic releases of sugar should be reviewed so that the markets might function effectively. The Government of India have, however, decided that the time is not opportune for these steps, but will revise the situation later.

[1] *S. African Sugar J.*, 1957, **41**, 927.
[2] C. Czarnikow Ltd., *Sugar Review*, 1957, (331), 203.
[3] *Indian Trade J.*, 1957, **202**, 148.

Controlled Engineering Maintenance. H. E. HASTINGS. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 64–75.—A system of preventive maintenance is discussed. Visual controls advocated include the so-called Running Time Control Board, whereby a check is maintained of the running time of each machine unit and so pinpoints any immediate work to be done as well as jobs already overdue, and also a Work Allocation Board. A system of pay bonuses to reduce unnecessary overtime in maintenance and which allows penalties to be levied against such bonuses in the event of failure to carry out a particular job is recommended. As sugar factories carry out additional repairs and maintenance during the off-crop and during the week-ends, this system may not be applicable; larger companies budget for a 3% loss, and this caters for such stoppage causes as mill chokes, lack of steam, trip-out, etc.

* * *

Experience Gained in Simple Defecation during the 1955 Season. P. N. BOYES. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 76–81.—The fractional liming double heating defecation process was introduced in Tongaat in 1954, and attempts made in 1955 to improve clarification are discussed. Phosphate was apparently dissolving in the Oliver filtrates, and the muds were therefore continuously limed to counter this. A dense, slimeless cake, which peeled off the filters, was produced. With good mud retention, brilliant clear juices were produced. pH control is necessary, however, to prevent invert destruction. Cold liming was found to be unsatisfactory, manual pH control of the limed juice being difficult and causing over- and under-liming, which in turn caused darkening in the evaporators and so in the syrups and sugars. Filtration was poor, very heavy muds (10% solids) being produced, for which the bagacillo quantity was inadequate, resulting in poor retention. With fractional liming, a bagacillo ratio greater than 40% with satisfactory mud solids resulted in excellent retention and brilliant clear juice. Recirculation of the mud in cold liming caused cloudy juices. Data are given for molasses analysis, sugar pol and recovery for the period from before to after the cold liming experiment, and show higher sucrose losses and true molasses purities during cold liming, although sugar pol remained normal throughout. Sugar was darker during the experiment and boiling-house recovery dropped, increases in undetermined losses being probably due to fermentation at week-ends, when deterioration was greater from cold liming, in one case a subsider actually bubbling and frothing. Juice in contact with mud was always acid from cold liming (6·8–6·9 pH) and alkaline from fractional liming (7·1–7·4 pH), possibly explained by the formation of a more basic compound in the mud from fractional liming (possibly hydroxyapatite as opposed to tricalcium phosphate).

* * *

Some Further Remarks on Results obtained with the Defecation Process in Natal.[1] C. VAN DER POL. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 84–88.

* * *

Weighing the Syrup—A Tighter Control of the Sugar Factory. J. ANTONOWITZ. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 93–97.—The weighing of syrup instead of filter-cake to calculate the undetermined losses is recommended. Sucrose recovered in the sugar corresponds much more closely to the figure calculated by the *s-j-m* formula from the syrup purity than from mixed juice. Such a calculation made at Umfolozi factory in 1954/55 is given, and shows a difference of 9·818 ton sucrose in over 80,000 between the calculated figure and the amount actually recovered in the sugar. Since boiling-house recovery depends almost entirely on non-sucrose elimination, the weighing of syrup will provide a check on clarification, filtration and boiling. The quantitative determination of the ratio of non-sucrose in syrup to non-sucrose in mixed juice will give a quantitative estimation of the molasses quantity, and of the molasses-forming agents in the juice which are removed by filtration. Graphs are included which show the almost direct dependence of boiling-house recovery on non-sucrose elimination.

* * *

Some Notes on the Determination of the Grist of Sugars with Reference to the Mean Aperture-Coefficient of Variation Concept. D. HASTILOW. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 98–101.—The need for a suitable method of easily expressing variations in crystal size and shape is discussed, and an account given of the Mean Aperture and Coefficient of Variation method[2], developed and used by Tate & Lyle Ltd.

* * *

Report on Tests on the Escher Wyss Continuous Centrifugal at Illovo during November 1955. E. BEESLEY. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 102–109.—Tests carried out with a C4/4 Escher Wyss continuous centrifugal on first, second and third Mill White massecuites, and *A* and *B* raw sugar masse-

[1] *I.S.J.*, 1957, **59**, 218.
[2] *I.S.J.*, 1948, **50**, 149–150.

cuites, are discussed with the aid of detailed tabulated results. The Mill White massecuites were handled well, the moisture of the sugar, reducing sugars and ash content being comparable to those from the standard machines, although there was a slight increase in the quantity of lumps returned from the sieve to remelt and the crystals were smaller and duller, possibly due to crushing. The raw sugar *A*-massecuite was handled at a satisfactory rate, and required little wash-water, although the sugars had a high moisture content and would have to pass through a dryer and, because of the presence of lumps, through a coarse-mesh screen. The sugar produced from the *B*-massecuite was unsatisfactory in quality and the capacity of the centrifugal when working this was very low (5·51 and 2·14 tons/hr massecuite and sugar respectively). *A*-massecuite for affination and remelt was handled at a satisfactory rate, the sugar for remelt being of good quality and having very small wash-water requirements. The power consumption for the two drive motors and the molasses pumps for all the tests varied from 35 to 41 amps on a 500-volt 3-phase supply (30–40 h.p.). The centrifugals were easy to control, apart from the trouble experienced with feed variations during curing of the *B*-massecuite. General remarks are made on the centrifugal operation, and viscosity, Brix and temperature relationship for the molasses area given.

* * *

A New Possibility of Steam Economy in the Sugar Industry. C. BARDOUX. *Sucr. Franç.*, 1957, **98**, 115–116.—A method of increasing thermal efficiency is described, whereby vapours from the first evaporator body are re-compressed and used for heating the pans.

* * *

Automatic Centrifugal Operation and its Development in Sweden. O. MAGNUSSON. *Socker Handl.* II, 1956. **12**, 205–216.—The different types of centrifugal electrical equipment are described. The Ward-Leonard and commutator (Schrage) motor systems are considered more suitable for automatic centrifugal operation than other types mentioned. The VS–1500 slip-ring four-pole induction motor (Landsverk) is considered equally suitable for automatic operation although it is not used for this purpose. The latest installation (1956) at the Köpingebro factory comprises 14 Landsverk VS–1500 centrifugals (basket dia about 48 in, height about 24 in, speed of up to 1500 r.p.m.) with automatic Ward-Leonard equipment. The auxiliary devices described include a motor-driven or pneumatically regulated massecuite valve, and a motor-driven Landsverk discharger which acts on an impulse given by the centrifugal at a particular speed reduction. Among the controlling devices are the speed guard, which in some cases is combined with a tachometer generator, and the so-called charge indicator. The operational sequences are described in detail, and the article is illustrated with photographs of the centrifugal layouts and devices and with graphs showing running times and current diagrams for the WL and VS centrifugals.

* * *

Storage of Sugar. B. DIEDEN. *Socker Handl.* II, 1956, **13**, 15–29.—The development of sugar silos in Sweden and other countries is discussed, with special mention of the Weibull silos. A diagram of a 40,000-ton Weibull silo as constructed by Tate & Lyle Ltd. at the Plaistow Wharf refinery is given, as well as one of the SSA-Weibull refined sugar silo, which is described in detail. The relationship of the sugar moisture to the moisture content of the air is discussed, and values for critical temperature differences between external air and sugar with varying moisture content and changing temperature are tabulated. The necessary conditions for a state of equilibrium between sugar moisture content and relative humidity of the air as given by H. E. C. POWERS[1] are mentioned. A graph is given of the comparative costs of the American-type silo, of the Danish modification of this silo as erected at Odense[2] and of the SSA-Weibull silos. The costs are based on Swedish conditions in 1954, and show that for capacities of 10,000 tons and over the last-named is the cheapest, although the Danish silo (only one, i.e. of 7500 tons capacity, was included in the comparison) compares favourably. The SSA-Weibull silo, seven of which have been erected (four in Sweden, two in France, one in Italy), can be made of steel or pre-stressed concrete for the same money, and is equipped with special heating and ventilating systems. Hot air is circulated from the central tower via channels in the floor and walls to the roof space, heat loss being prevented by laying the concrete floor on a bed of porous gravel or similar material.

* * *

Further Notes on Mill Extraction Results. J. RAULT. *Proc. 30th Congr. S. African Sugar Tech. Assoc.*, 1956, 57–63.—The average extraction for the whole South African industry has increased only from 91·07 to 92·32 over the past 20 years, while bagasse pol is now 2·91% compared with 3·05% and moisture 53·18% instead of 52·11%. Reasons for this are discussed, and proposals for increasing mill extraction are considered. If extraction of all the factories were 95%, the extra sugar recovered would have been 27,000 tons, worth £675,000. Extraction data for the total mill and for each unit from 1933 to 1955 at Natal Estates, Mount Edgecombe factory, are tabulated. The causes of low extraction are considered to be a too rapid rise in throughput and the increasing amounts of extraneous matter on the cane. The addition of a powerful sixth mill is expected to make increased extraction possible with the same throughput. Extraction figures for Natal Estates are compared with those for another factory which obtains a higher extraction with its crusher a phenomenon which persists throughout the train.

[1] *I.S.J.*, 1954, **56**, 314.
[2] *I.S.J.*, 1954, **56**, 36.

Methods of Increasing the Durability of Heat-Exchange Tubes for the Sugar Industry. N. YU. TOBILEVICH *et al. Sakhar. Prom.*, 1957, (4), 47–53.—Results of tests carried out in Russia show that corrosion in heat-exchange pipes occurs primarily during the campaign and is caused by the juice, this being more intensive with pitting where the steam-condensate phase is encountered. The corrosion is continuous in the heating chambers and is uniform in carbon steel pipes. It is basically a result of the acidity of the juice. In raw juice reheaters and evaporators pitting gives rise to non-metallic impurities in the juice, especially sulphur, causes unevenness in the structure of the metal, local pressure and other defects in the tubes. Pitting is caused also by weak alkaline media, oxygen in the juice, and irregularity in sedimentation and removal of scum formed by evaporation of sugar juice. Various recommendations are made as to the type of metals satisfactory for heating chambers of diffusers and reheaters, and for evaporators.

* * *

Sucrose Solubility in Water according to Kaganov. J. HRUBÍSEK. *Listy Cukr.*, 1957, **73**, 107–108.—In this critical study of the formulae of HERZFELD, WIKLUND, KAGANOV, GRUT and TAYLOR, comparative values are tabulated for sucrose solubility in water at various temperatures. The Kaganov formula

$$\log H = -48{\cdot}71038 + \frac{1944{\cdot}261}{T} + 17{\cdot}17974 \log T,$$

where H = number of parts sugar to one part water and T = absolute temperature, is considered the best, being better than the HERZFELD empirical formula. Values are tabulated for temperatures from 0 to 100°C using the Kaganov formula, these closely corresponding to the experimental values obtained by SILIN at 25–100°C. In 68% of the cases the differences are <0·001–0·003, although they are greater at higher temperatures.

* * *

Bulk Sugar Handling System at Guánica (Puerto Rico). R. F. GOODWIN. *Sugar J.* (La.), 1957, **19**, (12), 46–47. The equipment includes a 2-ton electric Toledo batch scale which dumps its 2-ton load in 1 min. Portable conveyors feed the sugar either to the warehouses or to the ships. Sugar in the warehouse is withdrawn through a tunnel conveyor underneath and thence through a system of conveyors and via a Merrick "Weightometer" to the ship. Stowage is effected by conveyors which feed telescopic trimmers. The Guánica installation also handles sugar produced by other factories. Lorries carrying bins from which sugar can be dumped into a holding bin are weighed on platform scales. The sugar is taken by belt conveyors and hopper to a 24-inch warehouse filling belt. Outside sugar cannot be fed to the main belt while Guánica sugar is being fed. The loading of 8700 short tons on to a ship takes 25–26 hours as against five days previously. A telephone system has been installed between ship and warehouse, and a Foxboro indicator and recorder fitted to the "Weightometer" for controlling the ship loading rate. Removal of the sugar from the warehouse requires a nine-man shift instead of 98 men previously employed in loading from the pile. No loss in pol has been noted, and any losses are expected to be less than would occur with bag shipment.

* * *

Purification of Puerto Rican Sugar Cane Juices. B. F. SMITH, F. SANCHER NÍEVÍAZ, L. F. COLONZ and E. E. COLL. *Sugar J.* (La.), 1957, **19**, (12), 20–21, 58–61.—Juice purification tests were carried out using strongly basic anion exchangers and weakly acidic cation exchangers. The reverse cycle process used in 1955 was found to be preferable, although data from the experiments were too limited to permit reliable sugar recovery figures to be given. True purity increases of 6·9 and 6·1 in juice from two factories were obtained, roughly equivalent to 14–15 lb extra sucrose per ton of cane ground. The results of tests with the mixed bed process show the sugars to have ash, colour and turbidity values double those of the corresponding sugars obtained using the reverse cycle process. This fact, plus the high cost of regenerating chemicals, makes the mixed process unattractive for production of high-quality sugar directly from clarified juice.

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Boiler-House Practices in Louisiana Sugar Factories. E. L. DENNIS. *Paper presented to the* 1957 *Meeting, Amer. Soc. Sugar Cane Tech.*—The importance of the steam plant of a sugar factory is emphasized with regard to economic and efficient operation. Bagasse furnaces are discussed and improvements in design mentioned. Boiler operation is discussed in detail, including scale formation and the treatment of feed-water. A special warning is given against certain commercial "electronic" etc. water conditioning equipment. The maintenance of too high a water level in the boilers is condemned as poor practice, and the use of centrifugal feed pumps discussed. The data necessary for selection of such pumps is listed. After mentioning the need for instrumentation in the steam plant, without which records cannot be kept, the author concludes with mention of the possibilities of a central bagasse paper plant in Louisiana.

* * *

Mill Difficulties caused by Field Mechanization. *Sugar J.* (La.), 1957, **19**, (12), 53.—The need to reduce the amount of trash, stones, sand, etc., carried through the mill with the cane is emphasized in this discussion, which lists the major difficulties encountered in a sugar factory when field mechanization is developed.

* * *

Revolving Cane Knife Discussion. M. V. YARBROUGH *et al. Proceedings of the Amer. Soc. Sugar Cane Tech.*, 1950–57, **5**, 74–79.—This discussion covers the knife blade sections, material, and length of projection from the hub, as well as their shaping, sharpening, surfacing, and method of attachment to the hubs.

New Books and Bulletins

The South African Sugar Year Book, 1956-57. 268 pp; 8½×10½ in. (The South African Sugar Journal, 44 Stability Buildings, Smith Street, Durban, Natal). 1957. Price: 10s 0d.

This valuable reference work, which covers not only the sugar industry of Natal and Zululand, but also neighbouring countries including Angola, the Belgian Congo, East Africa, Mauritius, Mozambique, Somaliland and Southern Rhodesia, provides a wealth of detail on the South African sugar world, having a reference section, statistical section, and a section devoted to the individual milling enterprises. The first of these contains articles describing the present structure of the industry and the South African Sugar Association; while details are also given of the Natal Sugar Millers', the South African Cane Growers' and other Associations, the Sugar Industry Central Board, etc., and a number of pages devoted to the Mt. Edgecombe Experiment Station.

Statistics of sugar and cane production, prices, rail freight rates, etc., are given in the second of the above sections, while the third gives information on the plant, processes, staff and company particulars of the sugar firms, in some cases with illustrations. Similar details are given of certain of the sugar companies in the neighbouring countries mentioned above, while a further section records information on some of the advertisers in the Year Book. A small section of "Useful Information" includes conversion factors for volumes and weights, horse-power formulae, areas, etc., while a feature of the book is a number of special articles which supplement the industrial reviews and articles which appear as before.

These special articles include a description of sugar cane growing in Nigeria, the opening of the Sezela refinery, etc.; while the industrial reviews include the Annual Report of the South African Sugar Association and Cane Growers' Association, the report of the S.M.R.I., and an Annual Summary of Laboratory Reports for 1956/57, etc.

* * *

The Carbohydrates—Chemistry, Biochemistry Physiology. Ed. W. PIGMAN. 902 pp; 5¾×9 in. (Acadamic Press Inc., New York 3, U.S.A.: Academic Books Ltd., London, W.2). 1957. Price: $20.00; 143s 0d.

The main use of this book is presumed by the editor to be as a reference work for chemists, biochemists, industrialists, etc., and it is fitted for this task by the authoritative expert panel of contributors who have dealt in detail with the carbohydrates and their derivatives. The structure, stereochemistry, occurrence, properties and synthesis of monosaccharides; the esters, glycosides, simple acetals and thioacetals; polyols; acids and oxidation products; ethers, anhydrosugars and unsaturated derivatives and nitrogenous derivatives are all dealt with, as are the oligosaccharides; glycosides and glycosidases; identification and quantitative determination of carbohydrates; polysaccharides; photosynthesis and metabolism of carbohydrates; and carbohydrates in nutrition. Some idea of the detail of the volume can be judged from the fact that the author index occupies 30 pages and the subject index 51.

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British Chemical Plant, 1957. 402 pp; 8½×11 in. (British Chemical Plant Manufacturers' Association, 14 Suffolk Street, London, S.W.1). 1957. Free on application.

The latest edition of this biennial publication[1] follows the same pattern as before, with a list of members with their addresses and overseas agents; an illustrated section of members' advertisements; and a classified index of products and services prefaced by advice to enquirers and followed by a key in French, German and Spanish. In the last edition there were 211 members compared with 222 in the current edition, while the number of advertisements is increased from 121 to 126 and the number of headings and subheadings in the classified index is 1347 compared with the previous 1325. A limited number of copies of the directory is available from the Association but not through booksellers.

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Jamaica—An Island Mosaic. PETER ABRAHAMS. 284 pp 5½×8½ in. (H.M. Stationery Office, Holborn Viaduct, London, E.C.1). 1957. Price: 25s 0d.

This book is another in the Corona Library series produced for the Colonial Office which has invited distinguished authors to visit the Crown Colonies and record their impressions. It says much that the author of the present in the series has since made his home on the island. His story is a mixture of the social and the historical, with sugar supplying only a background to certain aspects of the development of Jamaica, but he has achieved a colourful and interesting picture of the past and present which will be of value to all interested in the problems of a multiracial society and of the advancement of an under-developed territory.

[1] *I.S.J.*, 1956, **58**, 76.

LABORATORY METHODS AND CHEMICAL REPORTS

Thermal Decomposition of Hexoses and Industrial Consequences in the Beet Sugar Factory. J. DUBOURG, L. SAUNIER, P. DEVILLERS and A. LEMAITRE. *Paper presented to the Tenth Conf. Comm. Int. Tech. Sucr.* (*C.I.T.S.*), May 1957.—The transformation of the hexoses in alkaline and concentrated solutions is discussed. An account is given of variation of reducing sugars content of solutions which, when heated, showed progressively increasing colour—measured at pH 12 and 5800 Å—to a maximum after 2½ hours, when it diminished somewhat. Addition of NaOH to a solution gave no precipitate, but the colour of the liquid was four times greater than that of the filtrate from a solution to which lime had been added, causing separation of an amorphous precipitate. Further precipitation occurred on the addition of NaOH, whereas the liquid from the original NaOH addition gave no precipitate when calcium sucrate was added. Tests on the action of oxygen on hexoses and the effect of the presence of sodium sulphite are described and the results shown in graph form. A crystalline N-oside was isolated from a condensation of glucose and glycine, of a similar structure to that of a Schiff's base. When heated alone in a diluted aqueous or acid solution it decomposes, to give glycine and hydroxymethylfurfural, with slight formation of colouring matter. No glucose is liberated. Heated alone or with glucose in concentrated solution, it colours slowly, but if heated with glycine colours very quickly, liberating CO_2 as in the Maillard reaction, indicating the possibility that the Maillard reaction is continued by the action of a glycine molecule on the N-glucoside.

* * *

Lactic Acid Determination in some Factory Products. —. NAGY-TUMLIR and J. GENOTELLE. *Paper presented to the Tenth Conf. Comm. Int. Tech. Sucr.* (*C.I.T.S.*), May 1957.—The determinations are made according to a method of STARK, GOODBAN and OWENS, combined with a purification process using ion exchangers perfected by BRYANT and OWERELL. The strong cations and amino acids of the factory juices are fixed on cation exchangers, the other acids on an anion exchanger. The columns are washed and the lactic acid eluted with ammonium carbonate, a part of the extract being heated with conc. sulphuric acid to transform it into acetaldehyde, which gives a blue colour with *p*-hydroxydiphenyl which is compared with that from a standard solution. It is noted that the colour intensity after 30 min at 30°C is influenced by variations in the bath temperatures, the factor varying with the baths, but remaining constant for samples with the same bath. The error is at times 5%, and it is therefore impossible to establish a standard curve. By making two colour determinations for each sample and making corrections (the points obtained for 10 and 20γ lactic acid/c.c. are always parallel with the standard curve, but are displaced to the left or the right) the error was reduced to a maximum of about 10%. The average monthly lactic acid content in molasses from different factories are tabulated and compared with the corresponding undetermined losses. Molasses containing the least lactic acid came from factories with the lowest undeterminated losses, though there is no absolute correlation as it is difficult to make an accurate determination of factory losses. Lactic acid formation at various stages in the factory was studied, the tabulated results showing an increase on the amount in the raw juice after liming (due to destruction of the reducing agents in the raw juice by the lime). Lactic acid formed is about 20% of the reducing agents destroyed. Determination of the lactic acid content of diffusion juice before and after disinfection showed that the disinfection caused an improvement in the juice, while the lactic acid content was halved. The number of tests was inadequate to establish a relationship between the lactic acid content and sugars destroyed, however.

* * *

Rapid Methods for Determination of Moisture in Beet Pulp. G. S. BENIN and V. A. TSIRUL'. *Sakhar. Prom.*, 1956, (12), 51–53; through *S.I.A.*, 1957, **19**, Abs. 269.—Two procedures are fully described: (1) the use of CHIZHOVA's apparatus, consisting of two electrically-heated plates between which a layer of pulp can be heated at a definite temperature, the moisture being found from the weight loss; (2) open distillation of moisture from the sample mixed with dry paraffin wax in a crucible which is weighed before and after heating at a definite temperature.

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The Maillard Reaction. J. DUBOURG and P. DEVILLERS. *Sucr. Franç.*, 1957, **98**, 113–115.—Interaction of glycine with glucose and other sugars (galactose, lactose and maltose) by heating equimolecular quantities in a 50% aqueous solution at 95°C is followed by chromatographic examination of the products, and one N-oside compound, $C_8H_{15}O_7N$, isolated from the glucose reaction after 2 hr by adsorption (with glycine) on a cation exchanger, followed by preferential elution with dilute ammonia. With the corresponding compounds from the other sugars, cellulose and carbon column chromatography afforded partial separation, but the products were impure, degradation occurring on the carbon columns.

* * *

Dry Thermal Decomposition of Sucrose. H. HIRSCHMÜLLER. *Paper presented to the 10th Conf. Comm. Int. Tech. Sucr.* (*C.I.T.S.*), May 1957.—The changes undergone by sucrose on slow heating to 140°C or higher are discussed, and the difficulties of obtaining accurate experimental results are pointed out, including the catalytic action of trace impurities and the effects of different rates of heating. The loss of dextro-rotation of the sucrose depends on the sugar purity and increases with heating time and temperature, and

the reactions concerned are noted. Further heating produces caramelization at a temperature of 180°C, while foaming liberates CO_2, CO, formaldehyde. acetaldehyde, benzaldehyde, acetone, methanol, acrolein, formic acid, acetic acid, furfural, and phenol derivatives. In the melts the following have been identified in addition to sucrose: glucose, fructose, glucosan, fructosan, glucosin, fructosin, glyceraldehyde, dihydroxyacetone, pyruvic acid, hydroxymethylfurfural and humic substances. No measurable relation has been found between the rate of thermal decomposition and the impurities as determined in the factory (i.e. ash, colour, conductivity). Addition of up to 1% by weight of various impurities to sucrose was followed by heating to 170°C for 15 min and measurement of the extinction coefficient of the melt at 436 mμ. The colour formation with all mixtures was at least as strong as with sucrose alone and varied with the nature of the impurity, e.g. NH_4Cl, betaine hydrochloride and ferric sulphate had a much greater effect than NaCl or KCl. No relation was found between the colour formed and inversion; on the contrary, an even and then strong coloration was found when inversion was slight. The purest sucrose experienced the greatest inversion, while impurities had a more or less buffer effect and also a pronounced effect on the acidity of the melts, due, not to the acidity of the added impurities, but to reactions forming acids during the heating. Greater acidity arises with increasing amounts of the same impurity, N compounds and ferrous sulphate having a strong effect and KCl and NaCl having a weak effect. Graphs show the relationship between colour formation and pH, both for addition of simple salts and binary mixtures of salts to sucrose. Experiments using production white sugar were carried out and required a temperature of 190° for 15 min. The resulting pH and colour values could not be correlated satisfactorily with those obtained with pure sucrose at 170°C.

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Reactions of Glucose and Fructose (Transformation, Decomposition and Formation of Colour Bodies). F. SCHNEIDER. *Paper presented to the 10th Conf. Comm. Int. Tech. Sucr.* (*C.I.T.S.*), May 1957.—A 70% solution of glucose produced no reversion products even on extended heating, while in the case of even a 20% solution of fructose such products were formed in a short time. These have been separated by paper chromatography and identified as difructosides. Their rate of formation increases with concentration of fructose, and they behave as reducing ketoses. Dimers are easily obtained by the action of conc. HCl on fructose, and the sequence of formation of the dimers and diheterolevulosan is discussed. Hydrogen ions probably have no catalytic effect, as the reaction takes in phosphate buffer at a pH about 8. Formation at equal speeds of a 1,2- and a 2,3-enediol occurs with glucose heated in a buffer of pH 6, with glucose and psicose being produced simultaneously. With glucose, however, fructose is formed from which psicose is produced. Another compound formed during the reaction is not separated from dihydroxyacetone by two-dimensional chromatography, and decomposes in neutral and more so in alkaline media. The fission products are rapidly converted to methyl glyoxal, acetol and lactic acid. Investigation of the influence at 50°C of Müller's solution and Na_2CO_3 without the Cu^{II}- complex showed that dihydroxy acetone formation occurred in parallel to the separation of Cu_2O. Mainly glycollic acid and glyceric acid were formed on invert determination with Müller's and Fehling's solutions at 50°C with only a little arabonic and erythroic acid. The Lobry de Bruyn isomerization was strongly influenced by the presence of α-amino-acids, particularly *iso*-leucine. The glucose–glutamic acid reaction is discussed, and a compound described which was isolated. Its behaviour is in general agreement with that of humic substances isolated by acid precipitation from molasses. These were spherocolloidal, with a mol. wt. ranging from 8000 to 15,000.

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Chromatographic Studies on the Composition of Amino-Acids in Diffusion and Thick Juices from the 1955/56 Campaign. P. PAVLAS and O. MELOUNOVÁ-HÄUSLEROVÁ. *Listy Cukr.*, 1957, **73**, 50–54.—Paper chromatographic studies of the amides and amino acids in diffusion and thick juices and their hydrolysates were carried out on samples from the 1955/56 campaign provided by factories in Bohemia, Moravia and Slovakia. Nine chromatograms are illustrated. The compounds principally found were: glutamic and aspartic acids, alanine, valine, phenylalanine, leucine and *iso*-leucine. Also identified were: cysteic acid, asparagine, glutamine, cystine, serine, glycine, threonine, tyrosine, γ-aminobutyric acid, methionine, tryptophane, lysine, histidine, arginine and probably ornithine, and asparagine and glutamine amides. The basic amino-acids constituted a comparatively weak component in the 1955 juices. No peptides were present, and proline and hydroxyproline were absent from the samples.

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Microbiological Testing of Sugars. B. HAMPL and V. ORSZÁGHOVÁ. *Listy Cukr.*, 1957, **73**, 59–60.—Results of tests on 50 sugar samples from the 1955 campaign, which are tabulated, showed such a fluctuation in the bacterial count per gram of sugar that it was impossible to draw any definite conclusions, as the larger numbers of organisms per gram were not proportional to the larger numbers of established thermophilic spore-forming bacteria. Such factors as transport, storage, packing materials, season of the year and choice of tests could have caused the fluctuations, and it is pointed out that only thermophilic, spore-forming aerobic and anaerobic bacteria, producing hydrogen sulphide, can be determined quantitatively, while the determination of anaerobic bacteria not forming H_2S can be only qualitative. The results of the tests agree with the standards used by the American canning industry for maximum bacterial content, i.e. a maximum of 125 thermophilic, spore-forming bacteria per 10 g of sugar, of which 50 aerobes with gas-free fermentation and a maximum of five H_2S-producing anaerobes.

UNITED STATES

Separation of Valuable Organic Compounds (Glutamic Acid and Betaine) from de-Sugared Molasses and Vinasse. J. VAN JULSINGHA, assr. N.V. CENTRALE SUIKER MIJ., of Amsterdam, Holland. **2,785,180.** 15th October 1953; 12th March 1957.—The prior[1] process is applied to e.g. Steffen's filtrate and vinasse after first concentrating to 25–40% water content.

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Method for Hydrolysing Dextran. L. J. NOVAK, assr. COMMONWEALTH ENGINEERING CO. OF OHIO, of Dayton, Ohio. **2,789,066.** 14th October 1953; 16th April 1957.—Clinical dextran is obtained by first heating an aqueous 10% solution of high mol. wt. native dextran adjusted with acid (H_2SO_4, HCl, phosphoric or acetic acid) to pH 1·2–1·26 mixed with 2·5–33·3% (7–10%) v/v of a water-miscible alcohol or ketone (isopropanol), EtOH, MeOH, acetone or dioxane). A reducing agent, e.g. 0·3–1·0% ascorbic acid, is added to inhibit development of oxidative solution-darkening reactions during hydrolysis. The isopropanol–water vaporization has a cooling effect and also lowers the initial viscosity of the solution, resulting in improved and more uniform heat transfer throughout the mass. The solution is heated slowly to e.g. about 85°C (100°C with dioxane) at a relative viscosity of 4·3–4·8 with 8–10% by vol. of water of isopropanol, and is maintained at that temperature for 40–50 min. It is then neutralized to pH 6·8–7 with NaOH solution, cooled to 35–45°C, decolorized with charcoal, deionized, clarified with kieselguhr, followed by precipitation of the clinical dextran fraction which can then be dehydrated using acetone or isopropyl alcohol and finally dried under vacuum at 50–80°C.

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Treatment of Waste Liquors from Beet Sugar Molasses. F. A. HOGLAN and M. J. BLISS, assrs. INTERNATIONAL MINERALS & CHEMICAL CORP. of Chicago, Ill. **2,789,135.** 1st July 1953; 16th April 1957.—Concentrated Steffen's filtrate is hydrolysed with $Ba(OH)_2$ (or BaO in presence of water), using 250–350 lb solid BaO per ton of filtrate containing 60–65% solids. Sufficient water is added to the mixture to give a homogeneous mixture, e.g. 250–500 lb per ton filtrate. The mixture is heated to 85–95°C for 2–2½ hr, after which the hydrolysate is neutralized to pH 6–10 (7–9·5) with an acid forming a soluble barium salt (HCl). Sufficient MeOH is added to complete precipitation of the barium glutamate. Usually about 3200–10,000 lb (3500–8000) MeOH per ton of conc. Steffen's filtrate is used, or 2–10 (5) parts MeOH per part filtrate. This precipitate containing the salt is filtered off, and contains 95% or more of the glutamic acid and 25% of the organic impurities originally in the filtrate. After separation of the barium as carbonate, the pH is adjusted to 4·5–7·5 (5) with H_2SO_4 or HCl and the solution concentrated to about 30–50% of original filtrate weight to crystallize the inorganic salts, the pH adjusted to 2·5–4 (3·2–3·6), and the glutamic acid recovered by isoelectric crystallization or as glutamic acid hydrochloride.

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Beet Harvesters. G. W. RICHARDSON, assr. T. BRIERLEY and A. COURTLEY, of Derker, Oldham, Lancs. **2,791,076**; **2,791,083.** 24th August 1953; 7th May 1957.

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Means of preventing Overloads on Cane Cutters, Cane Shredders and the like. M. D. CHURCH, assr. WORTHINGTON CORP., of Harrison, N.J. **2,791,252.** 24th August 1953; 7th May 1957.—A governor valve is placed on the steam supply line to a turbine driving a set of cane knives. A control mechanism is responsive to the pressure differential on either side of the governor and acts on a mechanism which opens or closes the steam supply valve for the turbine which drives the cane carrier.

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Process for Recovering Betaine Hydrochloride. J. W. SIETSEMA, assr. INTERNATIONAL MINERALS & CHEMICAL CORP., of New York. **2,795,603.** 26th November 1954; 11th July 1957.—Steffen's filtrate end liquor is concentrated to S.G. 1·2–1·5 (1·35–1·5) and the pH adjusted to <1·0 (0·5) e.g. with HCl. After standing with gentle agitation to permit the betaine and inorganic salts to crystallize, the resultant slurry is centrifuged for e.g. 10 min at 1600 r.p.m. while retaining the liquid phase. The betaine and inorganic salts collect at opposite surfaces, two solid phases being separated by a liquid phase. The betaine hydrochloride of 96% purity is then scraped from the surface, e.g. with a knife blade, or separated by convenient means, and is washed with 10% HCl and 10% (or 20%) acetone. The inorganic salts precipitate, comprising a large quantity of potassium salts, may be recovered by suitable means, e.g. filtration, or decanting. The liquid phase may be processed for glutamic acid and other amino-acids recivery, e.g. by hydrolysis with HCl at 100–125°C for ¼–4 hr or with alkali at 85°C for 2 hr, the pH then being adjusted to about 1·6, and the liquor obtained concentrated until salts crystallize; these are removed from the concentrate at 40–60°C and the pH adjusted to about 3·2 with alkali or anhydrous ammonia. The glutamic acid crystallizes and is recovered after standing for several days. Its purity is about 90–95%.

[1] *I.S.J.*, 1958, **60**, 25.

TRADE NOTICES

Statements published under this heading are based on information supplied by the firm or individual concerned. Literature can generally be obtained on request from the address given.

Fielden Level Control and Indication. Fielden Electronics Ltd., Wythenshawe, Manchester.

The "Aquatrol" level controller is suitable for level control of conducting liquids and provides a simple sensitive alarm, indication and/or on/off control. When suitable probes, connected to the unit, make or break contact with the liquid under observation, the relay incorporated in the unit opens or closes as required, operating an alarm or pump, etc.

The "Tektor" is applicable to practically any liquid or free-flowing solid, regardless of conductivity, insulation value, viscosity, density or corrosive properties, and in conditions of high temperature, pressure or vacuum. Its function is to maintain level at any desired point in any kind of container, and the instrument consists of a small electronic unit (which may be weather-proofed) and a probe, the latter being inserted into the container. The approach of any substance to (or recession from) the probe causes a change in capacitance which actuates a relay which can give a visible or audible alarm or stop or start mechanism so as to maintain the predetermined level.

The "Telstor" unit provides a continuous level indication of the contents of a tank, bin, silo, or other container, and can operate with practically any liquid or free-flowing solid. An electrode consists of a conductor reaching from top to bottom of the container, covered or bare as necessitated by conditions. This is sensitive to changes of the material surrounding it down its whole length, and the amount of change in capacitance, representing the portion of the electrode covered is noted by an electronic unit which gives a reading on an indicating meter which is fitted with adjustment controls for "Full and "Empty" calibration.

Fielden equipment is used by Tate & Lyle Ltd. and the British Sugar Corporation Ltd., among others, and is applicable to water, molasses, lime, sugar, coal, and sugar beet.

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"Compound" Water Meters. George Kent Ltd., Luton, Beds.

A new class of water meter combines long life and reliability with an extremely wide measuring range which, in the case of the 3-inch meter, is over 500:1 within accuracy limits of 2%. Two completely separate measuring units are used, one for high flows and the other for low flows, with an automatic change-over valve to select the unit required, and the whole is contained in a single compact meter body. Only one unit registers at a time, and the total flow is obtained by adding the flows recorded on the counter dials corresponding to each unit.

Dust Control Equipment. Dallow, Lambert & Co. Ltd., Thurmaston, Leicester.

A new range of self-induced spray-type wet dedusters, series MG, has been introduced in thirteen standard sizes ranging from 2000 to 48,000 c.f.m. capacity. The deduster has been subjected to intensive laboratory and field trials and is available with four different methods of sludge removal. No pumps, nozzles or other mechanical spray-producing equipment are employed, and the unit is considered suitable for use near installations for filling, weighing and drying of sugar.

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PUBLICATIONS RECEIVED

D.d.S. CONTINUOUS DIFFUSION. Akb. De danske Sukkerfabrikker, Slotsholmsgade 22, Copenhagen K, Denmark.

The advantages of the D.d.S. diffuser design are reviewed, with particular emphasis on the complete control of temperature which is obtained in all parts; ability to adapt for scalding of cossettes; the continuous positive movement of cossettes ensured by the continuous helical conveyors; the small effects caused by interruptions in processing; the small losses with low draught (e.g. 0·26% on beet at 109%, 0·16% at 110% and 0·14% at 115% for three factories in October 1957); the accessibility of all parts even when working; and the fact that expensive foundations are not required. Diffuser capacities vary from 250 to 2400 tons per 24 hr, and they are made under licence by manufacturers in Italy, Germany, France, U.S.A. and Holland.

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RICHARDSON GA-17 GROSS BAGGING SCALE WITH FEEDER. Richardson Scale Co., Clifton, N.J., U.S.A.

The GA-17 scale, described in Product Data sheet 5701, is designed for open-mouth textile and multi-wall paper bags and gives high-speed bagging of many materials in bags of 50–100 lb capacity. When the bag is slipped on the spout it is held in position by a cam grip holder. The operator pulls the handle to open the inlet gate and the belt feeder starts simultaneously. When the beam comes to balance, the feeder stops, and with the required amount in the bag the gate closes. The machine is completely automatic in operation and weighing, requiring only the positioning of the bag and opening of the gate by hand.

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SMITH ROTA PUMPS. A. & W. Smith & Co. Ltd., 21 Mincing Lane, London, E.C.3.

The Rota pumps are designed for handling massecuite, magma and other viscous liquids, and are available in six sizes with 4, 5, 6, 7, 9 and 11-inch diameter delivery branches. They can be supplied either right- or left-hand, and alternative drives include belt, electric motor with V-rope and spur reduction gear; electric motor with worm reduction gear, and a variable speed drive. They are described and illustrated in a new leaflet R.P.57, which is available in English and Spanish.

* * *

SILENT CHAIN DRIVES. Link-Belt Company, Prudential Plaza, Chicago 1, Ill., U.S.A.

Book 2425 contains tables of service factors, ratings, chain length and centre distance computations for the silent chain drives which are available for transmission of power ranging from less than one to thousands of horse-power. The chain is designed for long life and continuous and trouble-free operation, and its efficiency of better than 98% is unaltered by wear, temperature or atmospheric conditions.

INTERNATIONAL SOCIETY OF SUGAR CANE TECHNOLOGISTS

TENTH CONGRESS, 1959.

APPOINTMENTS have been announced for the Programme and Publications Committee of the Tenth Congress of the I.S.S.C.T., which will meet in Honolulu during 3rd—23rd May 1959.

Dr. L. D. BAVER, Director of the Experiment Station, Hawaiian Sugar Planters' Association, and General Chairman of the Congress, has appointed the following:—

Dr. ROGER P. HUMBERT, Principal Agronomist, Experiment Station, H.S.P.A., will be Chairman of the Programme & Publications Committee (*Address :* Experiment Station, H.S.P.A., Honolulu, Hawaii).

Dr. JOHN H. PAYNE, Principal Sugar Technologist, Experiment Station, H.S.P.A., Factory Section Chairman. (*Address :* Experiment Station, H.S.P.A., Honolulu, Hawaii).

J. P. N. BENTLEY, Factory Manager, Tongaat Sugar Co., South Africa, Milling Sub-Section Chairman. (*Address :* Tongaat Sugar Co., P.O. Box 5, Maidstone, Natal, South Africa).

C. N. DAVIS, Chief Chemist, Colonial Sugar Refining Co., Australia, Processing Sub-Section Chairman. (*Address :* 1 O'Connell Street, Sydney, N.S.W., Australia).

R. F. INNES, Director of Research, Jamaica Sugar Manufacturers' Assn., Agriculture Section Chairman. (*Address :* Mandeville P.O., Jamaica, B.W.I.).

Dr. H. M. TYSDAL, U.S. Department of Agriculture, Cane Breeding Section Chairman. (*Address :* Tobacco & Sugar Crops Section, U.S.D.A., Beltsville, Maryland).

C. G. HUGHES, Pathologist, Queensland, Australia, Pathology Section Chairman. (*Address :* Bureau of Sugar Experiment Stations, William Street, Brisbane, Queensland, Australia).

RALPH MATHES, Entomologist, U.S.D.A., Entomology Section Chairman. (*Address :* Experiment Station, Houma, Louisiana).

Papers in these sections will be presented during the week of 18th—22nd May 1959.

Dr. BAVER requests that two copies of all non-invitational papers be submitted. Abstracts must be received by 1st July 1958, and manuscripts by 1st November 1958.

In addition to Dr. BAVER, Officers for the Tenth Congress include: Dr. S. J. P. CHILTON, Head of the Department of Plant Pathology, Louisiana State University, Baton Rouge, Louisiana, who is General Vice-Chairman; and W. W. G. MOIR, American Factors Ltd., Honolulu, Hawaii, who is Secretary–Treasurer.

General Committee Chairmen include: Dr. JOHN N. WARNER, Senior Geneticist, Experiment Station, H.S.P.A., who heads the General Organizing Committee; and Dr. HUMBERT, of the Experiment Station, H.S.P.A., who is Programme Chairman.

The American Express Co. has been designated as official Transportation Agents for the Congress. They will handle transportation to Hawaii, hotels, and local travel in the Islands. All travel and accommodation arrangements should be made through the nearest American Express Co. office, or through their Honolulu office, 2388 Kalakaua Ave., Honolulu, Hawaii.

ICUMSA

H. C. S. DE WHALLEY, *President.*
D. GROSS, *Hon. Secretary.*

Referees of Agenda Subjects for the 12th Session to be held in Washington, D.C., U.S.A., from 2nd to 6th June are requested to forward three copies of their reports to the Hon. Secretary at the following address:—

TATE & LYLE RESEARCH LABORATORIES,
KESTON, KENT,
ENGLAND,

to reach him not later than 31st March. This co-operation will assist the officers to arrange the Session's Programme in good time. A further 100 copies of each report for distribution to the Session's delegates should be prepared and sent to the Hon. Secretary to reach him by 21st April.

Referees, Associate Referees and other delegates are referred to previous information published in the *I.S.J.*[1]

Salvaging of Paper Sacks.—B. W. Dyer & Co. of New York have recently issued a leaflet entitled "Profit from opening Paper Bags properly". This refers to the second-hand value of multi-wall paper sacks and gives illustrated instructions for opening of bags with the least damage.

* * *

Polish Sugar Machinery for Russia.[2]—The Polish sugar machinery industry will erect four new sugar factories in the Ukraine of 2500 metric tons per day slicing capacity each. The first equipment will be supplied in the second half of 1958, and the total cost is estimated at 94 million roubles (£8,400,000).

[1] 1957, **59**, 13–14; 1958, **60**, 16.
[2] F. O. LICHT, *Int. Sugar Rpt.*, 1957, **89**, (11), 9.

BREVITIES

Erratum.—In the abstract entitled "Investigation of Continuous Massecuite Boiling using Morze's Patented Apparatus" on p. 18 of our January issue, Z. NITSCHKE should have been named as co-author of the article with T. PIETRZYKOWSKI.

* * *

Mexico Sugar Production.[1]—The 1956/57 campaign in Mexico has closed with a production of 1,018,041 metric tons, *tel quel*, which compares with 744,130 tons the previous season. Production in each case consists of about 99% whites with small quantities of muscovados and piloncillo. In addition, there is usually about 80,000 tons of piloncillo produced by independent millers. The remarkable increase in output was due to an increase in cane production, which amounted to 11,349,357 tons compared with 8,585,216 tons in 1955/56. Sugar content, at 9%, was about average.

* * *

U.K. Terminal Market Contract Change.—Projected deliveries of fairly large quantities of Brazilian raws against the December contract, coinciding with the reimposition of the International Sugar Agreement quotas had an unsettling effect on the activity of the market and have led to a decision by the Market Association to limit the origins deliverable against contracts to Cuba, Haiti, the Dominican Republic or Taiwan, which are signatory countries. Because of the restrictions of Article 7 of the Agreement all sugars from non-signatories have to be imported into the U.K. under special licence against a fixed quota, and so long as quotas are in force such licences may be refused. The change took effect on 2nd January for deliveries from October 1958 onwards.

Stock Exchange Quotations

CLOSING MIDDLE

London Stocks (*at 20th January* 1958)	
Anglo-Ceylon (5s)	12/6
Antigua Sugar Factory (£1)	21/–
Booker Bros. (10s)	17/–
British Sugar Corp. (Ltd. (£1)	14/10½
Caroni Ord. (2s)	4/–
Caroni 6% Cum. Pref. (£1)	17/–
Distillers Co. Ltd. (6s. 8d units)	20/3
Gledhow Chaka's Kraal (£1)	54/–
Hulett & Sons (£1)	65/–
Incomati Estates (£1) Final Liquidation Payment	3/11·3
Jamaica Sugar Estates Ltd. (5s units)	6/9
Leach's Argentine (10s units)	6/3
Reynolds Bros. (£1)	46/6
St. Kitts (London) Ltd. (£1)	48/9
Ste. Madeleine (Ord.) (£1)	25/–
Sena Sugar Estates (10s)	25/1½
Tate & Lyle (£1)	53/7½
Tate & Lyle Investments Ltd. (5s)	8/9
Trinidad Sugar (5s stock units)	8/–
United Molasses (10s stock units)	27/3
West Indies Sugar Co. Ltd. (£1)	27/6

CLOSING MIDDLE

New York Stocks (*at 18th January* 1958)	$
American Crystal ($10)	30⅛
Amer. Sugar Ref. Co. ($100)	27½
Central Aguirre ($5)	18⅜
Cuban American ($10)	19⅛
Great Western Sugar	21⅜
South P.R. Sugar	27½
United Fruit Co.	39⅛
West Indies Sugar Corp. ($1)	66½

Töölö Refinery, Finland.—The Finnish Sugar Corporation have notified us that the reference to the dryers at their Töölö refinery[2] should have read "Rotary Louvre" instead of "Roto-Louvre" as they were supplied by Messrs. Dunford & Elliott Process Engineering Ltd., of London.

* * *

Queensland Sugar Crop Completed.[3]—The last of the Queensland sugar mills (Racecourse Mill) has ceased crushing, bringing the total sugar produced to 1,200,000 tons from just under 9 million tons of cane. This figure compares with 1,175,012 tons produced in 1956 and the record 1,301,245 tons produced in 1954.

* * *

Relative Cost of U.K. Sugar.[4]—Replying to a question in the House of Commons, the Joint Parliamentary Secretary to the Minister of Agriculture, Fisheries and Food stated that a comparison of the costs of sugar from Cuba, the Commonwealth and domestic producers was best made at the first-hand selling point, i.e. ex-refinery. In November, the list price of refined sugar was approximately 6d per lb after eliminating the distribution payment from the Sugar Board and that would be the current cost of foreign sugar. The Sugar Board had estimated that the comparable figure for Commonwealth sugar bought at the 1957 negotiated price would be about 7d per lb on current freight rates, and the British Sugar Corporation Ltd. had estimated that the equivalent figure for sugar produced from home-grown beet in the 1956/57 season would be about 6⅛d per lb.

* * *

Yorkshire Copper Works–I.C.I. Metals Merger Proposal.—Yorkshire Copper Works Ltd. and Imperial Chemical Industries Ltd. have been exploring methods of combining their activities in the copper and copper alloy tube and plate industry. Merger proposals were submitted to a meeting of the Yorkshire Copper Works Ltd. on 27th January, and include the formation of a new Company—Yorkshire Imperial Metals Ltd.—50% to be owned by each participating Company, which will receive all the assets of the Yorkshire Copper Works Ltd. and of that part of I.C.I. (Metals Division) consisting of the production, sale and distribution of copper and copper alloy tubes, ferrules, plates and tube fittings, lead and lead alloy sheet and pipe, and zinc chloride.

* * *

Cuban Crop Decree.—The Presidential decree fixing the Cuban output at 5·5 million Spanish tons, as recommended by the I.C.E.A., was published near the middle of January. The allocations are:—

	Spanish tons
U.S. Free Quota	1,872,690
U.S. Retained Quota	500,000
World Free Quota (held by producers)	1,500,000
World Free Quota (sold and to be sold by I.C.E.A.)	843,750
World Obligatory Reserve	243,375
Voluntary Reserve	249,185
Local Cuban Consumption	300,000
	5,500,000

C. Czarnikow Ltd. comment:[5] "The fixing of such a large free world quota has occasioned some surprise for it had been felt that the restriction of the quota of sugar available for immediate sale to a more modest figure as has happened before might have exerted some influence on the market—if only psychological."

[1] C. Czarnikow Ltd., *Sugar Review*, 1957, (334), 216.
[2] *I.S.J.*, 1957, **59**, 343.
[3] *Queensland News Letter*, 7th January 1958.
[4] *Brit. Sugar Beet Rev.*, 1957, **26**, 60.
[5] *Sugar Review*, 1958, (337), 15.